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Ironfoundries and the War

As the demand for war material gathers momentum the loss sustained by the cessation or diminution of peace-time activities is gradually being offset. In the supply of certain raw products the foundry is in a fortunate position. In the first place the bulk of its raw materials is derived from home sources of supply, and in the second place foundry manufacture is very widely scattered. This, however, must not blind us to the fact that war production raises many technical problems, in respect, for example, of that comparatively small proportion of the raw materials derived from overseas. Furthermore, the general matter of distribution of raw materials might, through matters of national policy, transport delay or other causes, necessitate the use of materials different from those with which the founder is familiar.

The matter which raises the most important technical questions is that commonly known as substitution, that is the substitution of cast iron for other materials, or more generally the extended uses of cast iron. The demand for malleable is such that this is of greater interest to grey-iron founders, but that does not mean that malleable iron founders are not interested, for the possibility of replacing any material by cast or malleable iron may spring from research work initiated years before when the possibility of such replacement could only have been envisaged in the most general terms.

In the fields of steel, certain non-ferrous metals (particularly aluminium) and timber there appear to be excellent chances for substitution. Founders will agree that such change should not be undertaken carelessly. There are certain products, such as rain-water spouting, which for special reasons have in certain cases been made in steel, and there is ample experience on which to base the replacement of such material by cast iron. In an adequately organised industry the change from cast iron would not have occurred in the first place. In other cases, it may be necessary to replace an engineering product by a straight copy in cast iron, on account of an existing design having determined its size and shape in relation to other parts. Sometimes a measure of redesign may be practicable, but in either case considerations of strength and other properties come in, and care must be taken that cast iron is not prejudiced by being used in such a way as to risk failure. Substitution then becomes a technical question, in spite of the support offered to the change by the immense improvements in foundry practice in continuous and mass production, in the increased precision of form in dimensions and design, in the greater uniformity and soundness, and in the variety of finishes available.

We referred a month ago to the interest being taken in this matter by the Ironfounders' National Committee. To extend the use of cast iron is indeed one of the major purposes for which this body has been founded. But before dealing with the activities of the I.N.C. in this direction, we may note that the industry itself has not been inactive. Many foundries have been pressed to cast articles formerly made by other methods. Others belonging to the great engineering works have as a matter of course turned to cast iron to replace, for example, what they formerly made in aluminium alloy castings or in fabricated steel. One important ironfoundry took a half-page advertisement in a leading national daily newspaper to show to architects, surveyors and contractors the advantages of cast-iron building members for hutments. The makers of a well-known type of valve have, in the national interest, embarked on a campaign to encourage the use of cast iron in place of gunmetal for their products. These are instances which point the way.

Merchandising Castings

In recent years, most of the national technical institutions have enlarged their scope to include the study of costing and process organisation, but the subject of selling has, generally speaking, been omitted. On several occasions, however, the Institute of British Foundrymen has given attention to the subject, and several new phases were stressed by Mr. R. B. Templeton in a recent lecture to the London Branch. His main theme was the stressing by foundry salesmen of the favourable ratio of cost to physical properties.

Obviously, in a meeting of such a character, various psychological aspects were brought to light, but one of the most important phases was entirely neglected. We refer to surface finish. By this we do not mean skin, for which some foundries have a high and well-justified reputation, but rather colour and gloss. It is no exaggeration to say that the application of vitreous enamel to cast iron has not merely conserved many lines of goods for the foundry, but has enabled it to extend its field. It is not only in the domain of cast iron where such progress has been registered, but also in the light-alloy field, where the anodising process has materially enhanced the sales appeal.

Perhaps the field where colour is of major importance is that of the supply of agricultural implements. According to the market, colour must be changed. The home and the more sophisticated dominion farmers seem to prefer

(*Continued on page* 248.)

Metals in Hiding

BY "ONLOOKER."

Owing to the heat and stress of wartime demand for munitions, it is probable that many manufacturers of non-ferrous products will find it very difficult to arrange for a proper stocktaking, for this entails a dead stop in production while weighing up is in progress. Actually the period of stocktaking does much more than provide the business man with an accurate record of the total weight and value of his stock-in-trade, for the necessity of securing an absolutely correct statement means that there must be an investigation into every hole and corner in order to discover what has been hidden away since the last reckoning was taken. It is remarkable what does come to light on these occasions of the annual overhaul, for even in the best regulated works there is a tendency for "awkward" stuff to be sidetracked and, once out of sight, it stays there, too often forgotten and unheeded, for many a long day. Perhaps in a really modern factory it is difficult for material to be lost sight of for any length of time, but in many works the "hidey-hole" is only too often in evidence and leads to any amount of trouble during the course of a twelvemonth. In theory, perhaps, stock records ought to reveal what is going on, but in practice it may not always work out that way.

Pruning "Dead" Stock

It is probable that the period since the war began, filled as it has been with tremendous activity, has made it doubly difficult for executives to keep their accustomed watch on this difficult question of stock accumulation, and there may well have been a tendency to let some things slide on account of this urgency. Quite apart from the question of valuable space in the metal warehouse, it behoves every manufacturer to see to it that "dead" stock is ruthlessly cut away by transfer to the foundry, for although there is no reason to suspect any shortage of essential metals, it is obviously in the national interest that every ton should be used, especially now that the paramount need of exports is being impressed upon the manufacturing community. Of course, it does happen that finished or semi-finished material gets sidetracked owing perhaps to some hitch over delivery, which may lead to cancellation eventually, or perhaps an error is made by the customer in giving sizes, thus landing the manufacturer with a product for which there is no immediate demand. On the offchance that it will come in for something else, the stuff is put on one side, but it is seldom that the chance occurs, and the material is forgotten. It goes against the grain to face the loss of a labour cost, but a fairly simple calculation will show what money can be lost by locking up material for a prolonged period.

Taking an "eye stock" means going through the various departments with notebook and pencil in an endeavour to estimate by visual judgment the weight of the material lying there. This is not a job for a beginner, for this method of assessing stock is full of pitfalls for the unwary and requires much experience if anything like an accurate total is to be arrived at. Even the tyro, however, can poke his nose into every nook and cranny in order to satisfy himself that hoarding of unwanted material is not going on, and it will be strange indeed if, as a result of such an investigation, a respectable tonnage is not added to the raw material stock from which the foundry is fed. A survey of this kind should be made periodically, for from the very nature of some of the sidetracked material it is as well that it should not be allowed to accumulate unduly.

Equilibria in Liquid Iron with Carbon and Silicon

RESULTS USING LAW OF MASS ACTION

MR. L. S. DARKEN has summarised in the following terms a Paper bearing the above title which he presented to the American Institution of Mining and Metallurgical Engineers:—

The application of the law of mass action to the homogeneous equilibria involving carbon and silicon in molten iron, on the assumption that the molecular species Fe_3C and Fe_3Si are present in such solutions, leads to a representation of the available data that brings them into substantial accord. These data include the solubility of graphite in liquid iron and in iron-silicon melts; the vapour pressure of the iron-carbon system at high temperatures and the CO-CO_2 ratio in equilibrium with them; the heat of formation of iron carbide; the equilibrium between silicon and manganese in low-carbon molten steels and the respective oxides in the slag phase, and the deoxidising characteristics of silicon.

The consistency of the results of the calculations is regarded as an indication that the use of the simple form of the law of mass action is justified in the treatment of data on solutions in liquid iron provided that compound formation in the liquid is taken into account. The interpretation proposed is not valid over the whole range of concentrations (over 15 per cent. Si) in the iron-carbon-silicon liquid system, for it is probable that compounds other than Fe_3Si are present in appreciable concentrations at the higher silicon concentrations and at the lower temperatures. Although the method of treatment presented here leads to a consistent picture, which is in accord with a variety of experimental results, it is known to the author that at least one entirely different method of treatment leads to a correlation of experimental data that is essentially equally satisfactory. The validity of the extension of the method used here must depend on further and more accurate experimental data.

Founders' Forum

DIFFICULT BRONZE CASTINGS

Q.—What is the best way of running phosphor-bronze leading nut castings?

A.—One of the most satisfactory methods for running bronze leading nut castings is as shown in Fig. 1. The heavy section near the centre

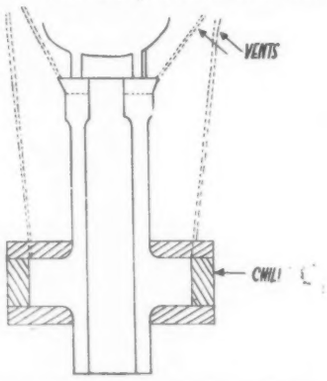

FIG. 1.—METHOD OF RUNNING PHOSPHOR-BRONZE LEADING NUT CASTING.

of the nut, which ultimately forms the worm-wheel, should be chilled and the casting poured from the top by two or more drop gates, according to the size of casting required. Vents should be taken from the chilled portion and from the top of the casting.

Random Shots

How often do people divide their fellow men into categories which allow only of two divisions, the do's and the don't's? To the golfing man, for instance, the whole world would seem to be divided in a very simple manner, those who do play golf and those who don't. The same is true also of the keen bridge player; an acquaintance is of no account unless he is an enthusiast, too, and either knowingly or unknowingly he weeds out everyone he meets on that basis, dropping those who don't play bridge and carefully cultivating those who do.

* * *

In a lesser degree the human species also can be divided into two other classes—those who look upon railway guides, maps and directories as mere tools for gaining information and those who can derive an enormous amount of quiet fun from them. The telephone directory already is well known as a source of amusement, with its classic example of the man of imagination who could not resist the temptation to pick up the receiver and ask, "Hello, are you Smellie?" on seeing that name in the directory.

* * *

A great game with maps on the same lines is to spread out any 1 inch to the mile Ordnance map and track the many churches to be found thereon. Begin anywhere on the map and it is an extraordinary fact that another can be found approximately two miles away in any direction, another two miles from that and so on in straight lines to the edge. As one chases them over the length and the breadth of the map, the game becomes quite hysterical in its excitement . . . well, pretty interesting, then.

* * *

But all this is a mere prelude to telling of the fun to be found even in such a staid and solid-looking volume as Ryland's Directory, the 1940 edition of which is just finding its way on to every managerial desk. Believe it or not, as a way of spending those few moments of relaxation over the old cup of tea, a perusal of its pages in this lighter vein can be recommended! It would be interesting to meet the man in the firm of "Love & Co.," who in a moment of delightful whimsicality hit upon the idea of registering his telegraphic address, "Jealousy, London." Imagine the scene at home, too, when an easily suspicious wife unscrews a slip of paper from her husband's pocket, on which he had scribbled a telegram to be sent to a business firm. The telegram would be addressed to "Bird, London," or even to "Clarissa, Liverpool." Then there is a firm of Tattersall, whose telegraphic address is "Wirepuller, London." Would a frantic telegram to them on the eve of the Derby persuade them to pull wires to see that by fair means or foul that rotten horse one has drawn in the office sweepstake would win?

* * *

And so it is possible to go on from absurdity to absurdity by dipping into its other sections. The socially ambitious man could ensure for himself at least three Countesses in his newly-erected suburban villa; a cooker, an electric fire, and a lawn mower.

* * *

The geographical section is no less interesting for there can be discovered some of the idiosyncrasies of the postal system. For instance, address a letter to Leighton Buzzard, Beds, and it may take a day longer to get there than if the county were left to the discretion of the post office!

"MARKSMAN."

A Study in Grey Cast Iron*

By H. J. YOUNG, M.I.Mech.E.

Cast iron is unique amongst metals. Since the time of Dr. Watt, 170 years ago, it has been a source of engineering conceptions. No other material known could have played its part. The numerous useful properties common to cast iron have become accepted as matters of course in the manner reserved for other beneficial phenomena. Almost a natural product, it has been allocated the degree of a maid of all work and no consequence.

Dependable and, metallurgically, docile; cheap and abundant; working for any master however ill-equipped with plant or knowledge; filling any mould to make any size, weight, shape, and thickness of casting; melted in a "Heath Robinson" cupola in intimate contact with coke of poor quality and a draught of unknown and uncontrolled volume and density, it will appear at the taphole as metal usable for castings, any rare failure on its part to do so being regarded as a miracle or an outrage. Within the mould, whilst transforming from hot liquid to cold solid, it expands slightly, thus taking upon itself the intimate contours of any pattern. Its pouring range is wide, particularly in its cheaper and more easiiy obtained qualities. It may be mishandled with less serious consequences than any other metal; for years past in hundreds of foundries of low degree, but successful in their spheres of action, it has withstood maltreatment all day and every day without retaliating sufficiently to fall into disfavour or to demand better handling.

Cast iron is excellent for things so extraordinarily different in size, importance, application and performance as to appear incredible when considered. As an inexpensive and efficient bearing metal it disposed of early engineering difficulties which would have been problems of first magnitude without it. To-day it is unrivalled in parts of that field. It withstands well the action of heat, cold, atmosphere, steam, gas, molten metal, oil, and water, even seawater, whilst remaining machinable and retaining good wearing properties.

No praise is too high for this friendly material which has received so little.

A Metallurgical Survey

This survey covers about thirty years' experience of making grey cast iron for castings. The earlier and major portion of this period was spent in a factory manufacturing all types of large marine and stationary engines, a factory which held for this country the world's record annual output of merchant marine engines. The remainder of the time was devoted to auxiliary units, automobiles, and aircraft.

By the year 1910 applied metallurgy had become commonly employed in the brass and copper tube and sheet industries; also in those trades dealing with propeller bronzes, red metals, gunmetals, and white bearing metals. It so happened that these manufactures provided the finest possible training ground for anyone destined to become a metallurgist in cast iron.

The youthful chemist full of college learning became convinced, by experience gained in non-ferrous works, that "mixture" is as important as composition; that variation of mixture inevitably produces effects for good or ill. For example, the behaviour of a metal in the foundry, rolling mill, machine shop, inspection department or under service conditions, is affected favourably or adversely, as the case may be, by using more, or less, scrap (metal from a previous melt) than the amount normally incorporated in the mixture.

No matter how obscure in those days the reason for these happenings, the student had to recognise them as facts. A further fact, learned at that time, concerned the great influence for better or worse exerted by the presence, or absence, of minute impurities—be they metals, non-metals, oxides or gases. Obviously, this explains why "mixture" and "scrap-content" are so vital. To say that a melting furnace is our only means of melting is a platitude, but it had to be learned that while a furnace is uncontrolled—be it for an hour or a year—the metal within is at its mercy.

Collected together, the germs of knowledge outlined above point to a great truth, namely, that it is almost, if not quite, impossible to make two exactly similar things. It follows, therefore, that no near approach to success can be attained unless every detail of a manufacturing process, however small, or apparently irrelevant, is recorded and kept as constant as care and ingenuity will ensure. It needs but consideration of the tests possible to apply to twin engines, castings, ships, furnaces, bars of metal, peas or anything else, the result of one or the other of which tests proves that the articles are dissimilar, to show that the metallurgist's task is no less complex, and no less well done, than that of the engineer.

The Iron Foundry Foreman of 1910

Entering, thus equipped, into marine engine practice proved a step into the unknown. Granted there was a large non-ferrous side dealing with gunmetal valves, propeller shaft liners, top end brasses, white-metalling, condenser tubes and tube plates; all of high importance, *but only subsidiary*. The works as a whole—estimating department, drawing office, pattern shop, machine and erecting shops, forge, boiler shops, and quayside—revolved around huge iron foundries, which set the pace for the remainder. The cast irons for the castings were compounded by the foundry foreman; nobody knew how he did it, but everyone agreed that nobody should interfere.

The metallurgist coming fresh into all this was disconcerted to find that scientific literature omitted not only to mention the iron foundry foreman's methods of making cast iron, but also forgot to provide any clue to their mechanism or theory.

Iron castings which take men down to the sea in ships are different from any other. Failure at sea spells salvage, demurrage, and repairs to a tune of thousands of pounds, including, possibly, a death roll. Failure within the works affects delivery dates with penalties attached; in any case, the machine shops, erecting shops and jetties have programmes mapped out months previously. Let it be remembered that to those days belonged the "Mauretania," a vessel not much exceeded in size or performance by very recent creations of its type.

It requires no imagination to appreciate that the old-time iron foundry foreman making irons for marine engine castings knew something worth knowing. Without the aid of what is called education he co-operated with engineers to render the British mercantile marine as safe, efficient, and great then as now; to wit, a born research worker, seeking knowledge in a blackout of information that would render impotent the average individual. Further, he held his job by sheer merit of results. Fail, and he had to go; for nothing could be unduly delayed and nothing risked in a marine engineering works of this magnitude.

He compounded his cast irons by reference to a little book kept usually in his pocket. The behaviour of his products—within the works or in service—varied seldom. In the rare event of things going wrong, he blamed everything but the little book, to which he adhered rigidly through fair weather and foul. In effect, *he did not vary his mixtures*, thereby indicating knowledge which took the metallurgist months to find and years to apply. His mixtures of iron were based assuredly upon sound theory, first, because they were successful, and second, because the most theoretical of all individuals is the practical man who devises his own methods.

By overwhelming evidence, therefore, the methods of the iron foundry foreman of those days were right methods, which science could build upon with supreme confidence. So time has proven.

The Start of Metallurgical Control

A year's intensive study disclosed the mechanism of so-called "rule of thumb" foundry practice. Hundreds of analyses were made of pig-irons and hematites, of the cast irons produced by the mixtures from the foreman's little book. Every detail of the daily practice was logged; synthetic compositions, melting practice, analyses, casting times, weights and thicknesses, physical tests, service results and all else were allocated a pigeon-hole in a seen-at-a-glance record. A microscope with a "home-made" optical bench was brought into use. The significance of pearlitic structure became suspected for the first time.

By means of a miniature cupola standing on a bench it was revealed that a cast iron made from all "scrap" was different from an iron of the same composition but made from all pig, that each remelting made a difference even when the composition was maintained constant throughout; that an iron containing 25 per cent. of steel in the mixture was different from one containing no steel, though both had the same analysis.

Thus, scientific control of the iron foundries became tangible and, finally, was obtained. A significant point is that no difficulty has since been found in working in friendly and close co-operation with experienced iron foundry foremen—this experience is without exception in Great Britain, Germany, and Holland.

Marine Engine Development

Scientific iron foundry control was timed fortunately. There arrived almost immediately the problem of cylinder wear under superheat conditions. Marine engines using wet saturated steam were converted to use dry superheated steam, with the result that one voyage across the Atlantic gave so much bore-wear that a remedy had to be found urgently. Cylinder liners were made and, with the records available from many engines at sea, together with those mentioned above, consistently good-wearing iron was soon discovered. The logging system described enabled anything proving suitable to be reproduced, while material which proved better or worse could be studied.

On the heels of superheated steam came Diesel engines, 1,000 h.p. per cylinder. At first these cylinders were cast head and body in one casting; but as the cylinder heads weighed 5½ tons and had some forty cores, it was decided later to cast them separately. For some inexplicable reason the body or barrel of the cylinder, when cast by itself, was called a cylinder liner, a misleading description which has persisted.

The Diesel liners weighed two tons and more and, when machined, had to be "pin-prick" perfect. Under the inspection of Classification Societies they were tested to 2,500 lb. per sq. in., tapped all round with a heavy hand hammer, and condemned for the slightest weeping or sweating. The irons had a tensile strength of 16 to 19 tons per sq. in. on *test bars cut out of the casting-heads*, which were not less than 5 inches thick. It is worthy of remark that *all* test bars were cut out of "heads" or thick extension pieces in the case of superheated

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* From an article appearing in the Journal of the Institution of Mechanical Engineers. The author is on the staff of Sheepbridge Stokes Centrifugal Castings Company, Limited.

steam, Diesel, and turbine castings. This was introduced because it was found that a separately-cast test bar, or a bar cast in shape and attached by runners to the main casting, represented nothing save itself. A test bar cast in shape on a cylinder liner of good-wearing iron was white or mottled when the iron was correct for the liner; a bar cast in shape on a large turbine casing might give a tensile strength of 15 tons per sq. in., but a bar cut out of the thickness of the casing itself might show a tensile strength of only 8 or 9 tons per sq. in. The mass-effect of a large casting cannot be reproduced in, or be represented by, a test bar cast separately or cast to shape and attached. It was due to the adoption of these methods of testing that progress was made.

Came the Great War. Output and quality of castings had to be maintained and the tests of Classification Societies, Lloyds, Board of Trade, and Government to be passed. Meanwhile, the quality of raw materials became such as would have been considered impossible to use before the war.

The Sulphur Fallacy

Two wartime occurrences may be mentioned. One was the discovery that the higher the sulphur in a good cast iron the better it wears as a cylinder liner. This fact upset a fallacy, which had persisted because sulphur, being liable to lead a foundry into trouble and being blamed whatever the trouble, was avoided by foundrymen like poison. The best-wearing large liners of that type contained 0.24 per cent. of sulphur, about twice the maximum amount ever employed up to then. This work led to the revelation of the part played by the sulphur-manganese balance, later published in 1921.*

Another happening having far-reaching effects concerned an engineering works in China with big Government contracts to fulfil, but unable to obtain pig-irons of which they were able to make castings. Finally, the pig-irons and hematites—all of unusual type—were examined and analysed in this country and the foundry in China was supplied with a complete range of mixtures, together with cupola-working and charging instructions. The results were completely successful.

The advantages of metallurgical control were extended in other ways after the war. For example, the foundry of a firm making reciprocating, turbine, and Diesel castings for the highest classes of passenger and war ships, was placed under scientific control. The aim was to produce all the castings from no other raw materials whatsoever save scrap iron, scrap steel, ferro-manganese, and the pig-iron and hematite from two local ironworks, which irons were the cheapest obtainable in these islands. The saving on cost of raw materials was very substantial. Into the bargain, the strength of all products was much increased, variation in quality was practically eliminated, and machine shop results were uniformly improved.

No alloy irons were used in those days. For one thing they had not become popular and, for another, the metallurgist was instructed to make castings, as one managing director put it, "of brains rather than platinum." In British Standard Specification No. 786 of 1938 for high-duty cast irons, the highest grade must have a tensile strength of 22 tons per sq. in. on a cast bar 0.876 in. in diameter and one of 18 tons per sq. in. on a cast bar 2.10 ins. in diameter. In the case of the firm mentioned above the strength of their Diesel cast iron was regularly 18 to 21 tons per sq. in., and that was ten years ago with iron made very inexpensively.

This survey confines itself to straight grey cast irons and none of its remarks applies to alloy irons, such as the nickel or nickel-chromium series or "loded" irons of the chromium-silicon series.

In 1921, marine engineers were introduced to the metallurgy of cast iron in the following words: "Grey cast iron is a very high-carbon steel cut up by and surrounding innumerable plates of graphite, that is, a matrix of steel containing many spaces filled with graphite." These flakes of graphite occur in the metal like caraway seeds in a cake. The "seeds" are without strength; hence, each resembles a little ditch more or less filled with graphite. When cast iron is machined, the cutting tool has to jump across these crevasses, with the result that the coil-to-be is severed and falls off, while the graphite sprays out of the ditch and blackens the operator's hands. Owing to the crevasses the surface of grey cast iron is discontinuous; therefore, a film of any liquid is retained upon its surface because it can, so to speak, obtain a foothold. This explains why cast iron is a good bearing metal, even with water as lubricant when conditions permit of the existence of a water film, as with saturated steam. Steel having no crevasses presents a continuous surface; hence, it does not "wet" easily and is a bad bearing metal. Other bearing metals than cast iron provide discontinuity of surface by reason of hard particles set in a relatively softer matrix, or the reverse. The bearing qualities of the surface of cast iron may be enhanced sometimes by phosphide which, being harder than the iron itself and insoluble in it, stands up as little hills in slight relief when the metal is polished as in a bearing.

Cast iron has no elongation because the graphite voids prevent it. Many qualities of it tend to "grow" under repeated heatings and coolings, because air penetrates the voids, causing oxidation and swelling.

If a freshly cast unmachined bar be accurately measured and tumbled in a barrel, it will have become slightly longer and stronger. The bolt holes of the top and bottom turbine casings of ocean-going vessels were found not to be fairly square one to another when the engines were opened out after the first voyage. It follows that the relief of internal stresses is a matter for decision when dealing with certain types of iron castings; heating at 400 to 450 deg. C. enhances the tensile strength by 0.25 to 0.5 ton per sq. in.

Strength and Section

The qualities of any one type of cast iron vary profoundly according to the casting thickness, because the cooling rate in the mould determines the grain size, the size of the pearlite lamellæ, and the size and amount of the graphite flakes. A wedge-shaped casting, say, 6 ft. long and 5 in. square at the large end, and tapering to a point at the other, will be found to have soft, weak and graphitic iron at the thick end, but hard and almost white iron at the thin end. Somewhere along the wedge the iron will be all-pearlitic and in its best condition. The position where this maximum quality occurs depends upon the silicon content of the iron used to cast the wedge; the lower the silicon, the nearer the best area will be to the thick end, and *vice versa*. It is necessary, therefore, to use a silicon content suited to the mass and thickness of the casting to be made. Obviously, this is impossible with a complicated casting containing many and varying sections, and chills need to be used which, unfortunately, give rise to stresses, local hardness and so on. A chill modified to act only to increase density is more efficacious. Each design of casting is a study in itself. A foundry can learn and progress only from its failures.

Complicated castings having practically the same structure and grain throughout all sections are producible by the Lanz "Perlit" process, in which the mould is saturated with heat units by prolonged preheating before pouring. With a mould thus prepared the cooling of the molten iron in the thin sections is delayed by the contact of its surface with heat-laden sand of which the thermal conductivity has been much reduced. It will be appreciated that the surface area per pound of iron contained in a mould section of a certain thickness becomes progressively less as the section becomes greater. Consequently, in a cold mould the thinner the section the quicker the cooling, while, in a hot mould, the reverse is true. Using cold moulds it is necessary to have a silicon content to suit the thinnest sections of the casting; using hot moulds, the silicon is adjusted to suit the thickest sections.

Another process of interest is the "Meehanite" process, which has been brought to commercial success by Mr. Oliver Smalley. Here, accurate control having been established, the iron is treated with calcium silicide at the furnace outlet.

The individually cast piston ring process also is intriguing; by it even the smallest automobile piston rings, say those for an "Austin 7," are cast singly.

In contradistinction is the centrifugal method in which the metal is spun inside a revolving mould. This process, now firmly established, was pioneered by the Sheepbridge Stokes Centrifugal Castings Company. Many piston ring quills or pots, cylinder liners and so on, produced in this manner, are favoured for automobile and aircraft engines of the highest classes.

Space permits of no more than bare mention of the various processes named above, but each has its own metallurgy. The possibilities of plain grey cast iron are not exhausted, for it has received much less attention than more exalted and more costly materials The above thirty-year record appears to demonstrate this without doubt.

* Trans. Inst. Mar. Eng., 1921-2, vol. 33, p. 655.

The Late Mr. Sherburn

A TRIBUTE FROM MANCHESTER

Reference was made at the March meeting of the Lancashire Branch of the Institute of British Foundrymen to the loss the Institute had sustained by the death of Mr. W. H. Sherburn, of Warrington.

MR. T. MAKEMSON, in paying tribute to the memory of the deceased member, said that it was Mr. Sherburn who had started the Branch 35 years ago. He understood that Mr. Sherburn was its first Secretary, or at least, a very early one. He was amongst its Presidents at that time, and probably its secretary and treasurer as well. For many years he took a very close and active interest in the Branch, attending its meetings, and being acquainted with all its members. He always took part in the discussions upon the various Papers presented, and it was virtually correct to say that 20 years ago he almost embodied the Lancashire Branch. Perhaps only the very oldest members realised just how much the Institute generally owed to the services of Mr. Sherburn. It was he, and one or two other people like him in other parts of the country, who nurtured the Institute when it was still struggling. He placed it upon a sound foundation, and the Institute members were now reaping the benefit of his efforts.

Apart from his work for the Institute, Mr. Sherburn devoted a great deal of his time doing things for other people. He was interested in both the Co-operative and the adult school movement, beside being very widely read and intensely interested in education generally, his idea being to help to uplift the ordinary working man and craftsman and to bring about better conditions in their working life and social environment.

Mr. Sherburn possessed a most wonderful character. Those who knew him intimately, and Mr. Makemson claimed to be among them, had the greatest possible admiration for him. He reached a ripe old age, and was nearly 87 years old when he died. Regret that was felt at his passing was mixed with a great deal of satisfaction that it was the close of a very useful life.

Malleable Cast Iron

By H. G. HALL

(*Continued from page* 228.)

Pearlitic Malleable

Additional types of malleable have recently been developed, called "pearlitic malleable," "heat-treated malleable," and malleable under various trade names, such as "Promal," "Z metal," etc. The American Foundrymen's Association has put forward the following tentative definition:—

"Any material which starts out as white cast iron, and is subsequently heat-treated to produce graphitisation, is to be called 'pearlitic malleable,' if the graphitisation be purposely terminated when sufficient combined carbon remains, significantly to affect the properties of the product. The combined carbon is often present as pearlite, sorbite, or might be martensite or some other form of decomposition product of austenite."

Pearlitic malleable can be divided into two main groups, produced by (1) stopping the annealing process before graphitisation is complete, or (2) reheating completely graphitised metal.

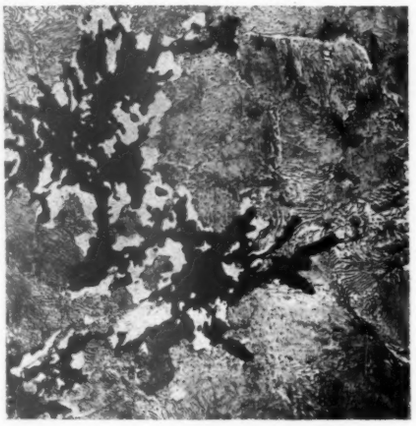


Fig. 15.—Temper Carbon in Ferrite in Pearlite Matrix. Etched Picric Acid. × 250.

Consider the first group from Fig. 10. At the highest temperature (900 deg. C.) reached during annealing the structure consists of austenite, graphite, and still some free cementite, and if first-stage graphitisation was stopped here, and the normal cooling was allowed (thus permitting complete second-stage graphitisation), the final product would have a structure consisting of some primary cementite, in the normal ferrite-temper carbon background.

Such a material could be used for resistance to wear in the same way as Babbitt metal, containing as it does a hard constituent (cementite) embedded in a soft material (ferrite), with the temper carbon acting as a definite aid to lubrication. By cooling at a fast rate from Y second-stage graphitisation would be prohibited, the solid solution of austenite at this point containing 0.4 to 0.6 per cent. carbon changing almost completely into pearlite.

The structure finally obtained would be temper-carbon nodules in lakes of ferrite—what is commonly known as a "bull's eye" structure. This structure is shown in Fig. 15. The tensile strength of such material would be in the region of 28 to 32 tons per sq. in., with 6 to 10 per cent. elongation; in other words, reasonably high strength plus a fair amount of ductility. The Brinell hardness of the "bull's eye" structure is shown graphically in Fig. 16.

There are certain difficulties in either of the methods just mentioned, for it is difficult, even with most accurate control, to stop graphitisation at a certain definite predetermined point. This annealing technique would naturally involve the use of special ovens. The second group is by far the most feasible—by reheating completely graphitised metal, thus not interfering with normal production. Actually the same fundamentals are involved as in the first group, because a completely graphitised iron reheated for sufficiently long periods above the A_1 critical point is, metallurgically speaking, identical with a white cast iron held to equilibrium at the same temperature. For instance, if heated to 840 deg. C., a temperature the same as the point previously indicated, and allowed sufficient time at that temperature, the structure would be austenite of about 0.9 per cent. carbon content and temper-carbon nodules. Air-cooling would allow the austenite to decompose into pearlite. The final product would be "bull's eye" structures similar to those just shown.

On the other hand, oil-quenching from 840 deg. would result in the austenite decomposing into sorbite, and from water-quenching the austenite would probably decompose into martensite or troostite, depending on the sec-

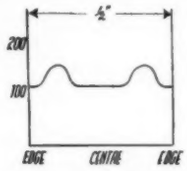


Fig. 16.—Brinell Hardness of "Bull's Eye" Structure.

tional thickness and how drastic the quenching was. With a sorbitic structure, strengths as high as 35 tons per sq. in. with elongations of 4 to 5 per cent. can be attained. With martensite-troostite structures 40 to 45 tons per sq in. and elongations of 1 to 3 per cent. are usual.

Tempering Malleable

These quenched materials could with advantage be subjected to a tempering treatment such as is given to medium and high-carbon steels and with comparatively the same beneficial results. It will be seen, therefore, that almost any form of combined carbon can be produced at will by experienced operators with tensile strengths ranging from 20 to 45 tons per sq. in. and inversely elongations of 18 per cent. down to 1 or 2 per cent.

Influence of Alloying

So far the Paper has dealt with metals of normal composition suitable for complete graphitisation, but it will be readily seen that alterations of composition and the addition of alloys enlarge an already wide field. The influence of various elements on the stability of iron carbide during casting and upon graphitisation during annealing is as follows in order of importance:—*Those promoting graphitisation* are: Si, Al, Ni, Cu, Co and P, and *those rendering the carbides more stable* are: Mo, W, Mn, V, S and Cr. Manganese is probably the most commonly used element in the production of the so-called pearlitic malleables, 0.5 to 1 per cent. above that used in normal production being fairly common. This element particularly affects second-stage graphitisation. Ladle additions of ferro-manganese to normal iron followed by normal annealing result in the retention of combined carbon from the second-stage graphitisation in quantities almost proportional to the amounts of manganese used.

There are certain dangers in ladle additions of any alloy which should be mentioned at this point, for if the original composition is a borderline one, the possibility of primary graphite separating out during casting is quite feasible. Obviously, also, the choice of an alloy to be used to stabilise the carbide must be one which, when diluted in the ordinary scrap, cannot affect the normal material in any way. Chromium, although useful for stabilising carbides in small amounts, is particularly dangerous unless production is entirely of the pearlitic malleable type.

The field of pearlitic malleable is also extending in the same direction as that of various alloy steels. For instance, Chubb stresses the advantages to be gained from a combination of very high silicon contents and the use of molybdenum, claiming that there is very little fear of primary graphite being precipitated during casting even in very thick sections, and claiming also that the high silicon will then allow of a reduction in annealing time. Incidentally he

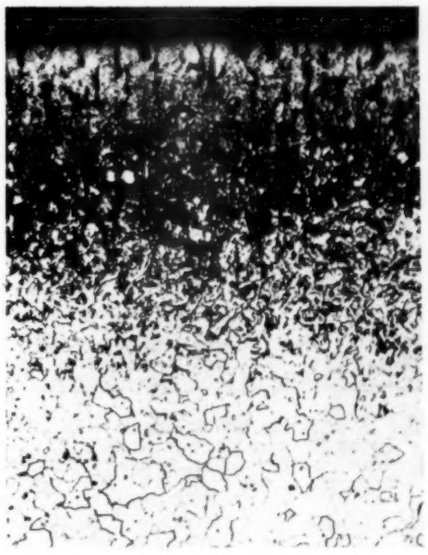


Fig. 17.—Example of a Good Case Produced by Cyanide Case-Hardening of Malleable. × 94.

gives figures as high as 47 tons tensile with 5 per cent. elongation, or 27 tons tensile with 17 per cent. elongation. Pearlitic malleable irons are usually of higher strength and lower elongation than normal blackheart, the permeability is lower and the net shrinkage from pattern size is rather less than that of normal blackheart probably due to incomplete graphitisation. The machining is obviously slower.

Cyanide Case-Hardening

Another specialised treatment of malleable which is particularly important at the moment is that of cyanide case-hardening. As the name implies, the process aims at producing an intensely hard surface suitable for resisting wear. The process consists of heating the malleable castings to and holding at 950 deg. C. or 900 deg. C. for 30 minutes in a cyanide salt bath. They are then either (1) quenched direct in oil, or (2) cooled in air, reheated in cyanide to 800 deg. and quenched in oil. This latter treatment gives somewhat better ductility, probably due to the partial tempering in heating up to 800 deg. C. again before final oil quenching. An intensely hard case of 550 to 600 V.P.H. (450 to 530 Brinell) is produced. The core hardness will vary according to the type of malleable used; obviously, true blackheart, particularly the high-silicon, low-carbon type, will be ren-

dered extremely hard and in most cases brittle by the drastic reheating and soaking.

The resolution of graphite and consequent precipitation of cementite are almost inevitable, and although V.P.N. figures of 200 to 250 in the core together with tensile strengths of over 40 tons can be obtained, the form and shape of the cementite usually render the material liable to failure by shock.

On the other hand, if whiteheart malleable is used, particularly if great care has been taken to achieve a very high degree of decarburisation, the case-hardening treatment will have little material effect on the core. The result is then an extremely hard case plus a moderately ductile core, capable of withstanding abrasion and shock. Failures to achieve this ideal are due to the core of the original castings, prior to treatment, being too hard, resulting in failure by shock, or when trying to avoid the above, such intensive decarburisation has been attempted that peeling has resulted. The effect of cyanide hardening a peeled skin of iron oxide need not be described.

Fig. 18.—Centre of Blackheart Section After 30 mins. Heating at 950 deg. C., then Oil-Quenched. Etched Sodium Picrate. × 400.

Fig. 17 shows a good case; the magnification is 94 and the depth of the case is 15/1,000. Fig. 18 shows the centre of a blackheart section after 30 mins. at 950 deg. C., followed by a direct oil-quench. The resolution of the graphite and the consequent appearance of the cementite render this core rather brittle. Fig. 19 shows the centre of a similar whiteheart section after treating, the difference in ductility being very apparent.

Fig. 20 shows another example of blackheart, which was air-cooled, reheated to 800 deg. C., and oil-quenched. The core would be considered fairly satisfactory.

A rough idea of the way the hardness jumps for whiteheart and blackheart after cyanide case-hardening is given in Figs. 11 and 12, where these hardnesses are shown as dotted lines.

Effect of Various Elements

Though it is usual to deal with the elements separately, it is felt that the effect of carbon must be considered together with that of silicon, for a high carbon necessarily means a low silicon in order to avoid the precipitation of primary graphite in the original hard casting. *Vice versa*, low total carbons are naturally associated with high silicon contents.

The choice of a suitable carbon content for normal production depends essentially on the type of casting to be produced. Obviously better physical results can be expected in either blackheart or whiteheart, the lower the total carbon. For instance 2.3 per cent. carbon would give approximately 24 tons and 18 per cent. elongation, whilst 3.3 per cent. carbon would give 19 tons and 12 per cent. elongation on 0.564 in. dia. bars—both being annealed to give a true blackheart of ferrite and temper carbon. This is mainly due to the difference in size and amounts of temper carbon, although it can be definitely stated that the ferrite strength is increased with increased silicon percentages.

From a practical and commercial point of view, successful production of thin and intricate small-section castings necessitates rather high total carbons, and naturally the heavier the general run of castings, the lower the total carbon can be. Here again there is a practical low limit for normal production, this being about 2.3 to 2.5 per cent. C. Below this point, casting difficulties offset the possible physical-test and annealing advantages.

Various elaborate formulæ have been given correlating carbon and silicon percentages, and although these form a good guide, they may not always apply to the type of furnace and melting conditions, and a certain amount of trial and error is necessary before standardising on definite percentages.

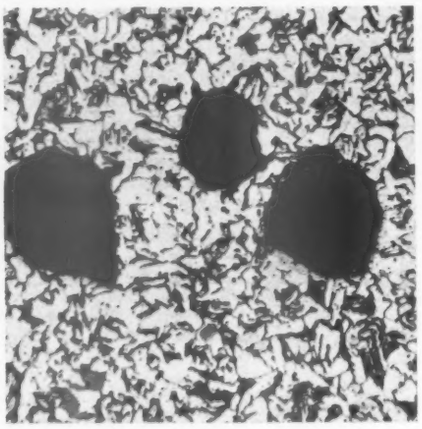


Fig. 19.—Centre of Whiteheart Section After Same Treatment as for Fig. 18.

So far reference has been made to normal production because the use of very low total carbons and high silicons is the very basis of short-cycle malleable irons, carbons of 1.5 to 1.7 per cent. and silicons of 2.0 to 2.5 per cent. being fairly common. These border-line compositions are very susceptible to melting and pouring-temperature variations, and are thus prone to the production of primary graphite. Control therefore must be extremely accurate or otherwise worthless material may escape the inspectors. Fig. 21 illustrates the fracture of a 3-in. section of a "white" cast iron showing mottle, and Fig. 22 shows the type of graphite resulting after annealing iron containing primary graphite. Such iron is inferior to ordinary grey cast iron.

Unfortunately border-line compositions are apt to precipitate primary graphite in unexpected places, such as thin sections, with the thicker sections perfectly normal. This often happens at local hot spots in the mould and can easily escape detection until the casting fails in service.

Manganese and Sulphur

Manganese must be considered in connection with sulphur. For successful graphitisation manganese must be present in such proportions as to balance the sulphur, *i.e.*, manganese should be present in the atomic ratio of 1.72 times the percentage of sulphur. Sulphur is then present as manganese sulphide. As a safety factor in the production of blackheart, a slight excess in the region of 0.1 to 0.2 per cent. is usually maintained. For the production of whiteheart, the sulphur and manganese should be present in equal percentages to ensure the presence of ferrous sulphide, so restraining graphitisation and speeding up decarburisation. Even so high a sulphur content as about 0.4 per cent. should be avoided, particularly in heavy-section castings, as this would necessitate such prolonged high temperature annealing, to eliminate primary cementite, as to be commercially impracticable.

Influence of Phosphorus

Phosphorus is rarely found above 0.1 per cent. in this country and can be as high as 0.2 per cent. without material effect. Above 0.2 per cent. it is not soluble in the ferrite and forms iron phosphide, which, on account of its low melting point, must be avoided. In America, however, white-fracture malleable, sometimes called temper embrittlement or white ferrite, is often found when phosphorus contents of 0.2 per cent. are associated with high silicons. Forbes describes this malleable as "moderately ductile with practically no combined carbon, easily machinable, breaking with a white crystalline fracture and appearing normal under the microscope." He suggests that the white fracture is caused by the fracture following the crystal boundaries, thus exposing the surfaces of crystals and giving a steely appearance, whereas, in normal blackheart, when broken the crystals elongate to points and have no smooth reflecting surface. He also suggests as reasons: (1) Weakness of intercrystalline cement and/or (2) the extra strength of ferrite. In any case, the phenomenon is unknown in England because of the low phosphorus content of the irons used.

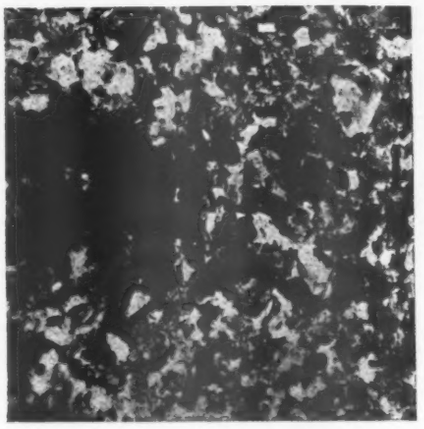


Fig. 20.—Blackheart After Air-Cooling, Reheating to 800 deg. C., and Oil-Quenching. × 400.

Alloy Additions

Much data have been published on the use of alloys in malleable iron, and these make interesting reading, but it is necessary to decide carefully if the advantages to be obtained from the use of alloys for the production of normal structure malleable will offset the increased cost. No reference is made to pearlitic malleables, for here the use of alloys, plus a trade name, plus careful propaganda, render the proposition a commercial possibility. A personal opinion is that the use of alloys to diminish the time of annealing, although this is a distinct possibility, rarely justifies the increased cost. Provided that the malleable produced conforms to a required specification, it is maintained that the engineer demands primarily maximum machining speed plus dimensional accuracy, plus reasonable finish, and it is doubtful if any alloyed malleable will give more satisfaction in these respects than correctly produced normal material.

The use of copper has been advocated as a means of reducing annealing time and graphite

size. These claims are undoubtedly correct, but to take full advantage of this element the annealing technique must be one involving the use of either small batch-type ovens capable of very accurate control or a continuous annealing furnace. Here again—given the above furnaces—it might be necessary to consider whether the extra cost of copper was justified.

Having mentioned reduction of graphite size, a digression seems desirable to discuss some recent experiments carried out by Schwartz, Schendler, and Elliot. Four samples of the same white cast iron were taken, and treated as follow: A was heated to 950 deg. C. for 1 hr., oil-quenched and tempered at 500 deg. C.; B was heated to 825 deg. C. for 1 hr., oil-quenched and tempered at 500 deg. C., and C was untreated. These three were then given a commercial anneal. The 4th sample, D, was heated for 73 days at 725 to 710 deg. C. All four samples were completely graphitised.

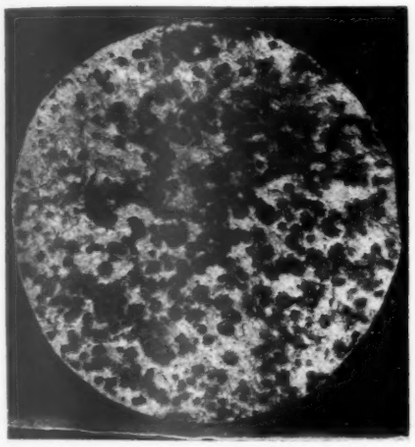


Fig. 21.—Fracture of 3-in. Section of "White" Cast Iron Showing Mottle.

In the case of A there were 40,000 nodules of temper carbon to each cubic mm.; for B there were 28,000; for C 135, and for D 30.

It seems therefore relatively simple to cause a given white iron to deposit a variety of sizes of temper carbon, and it would be interesting to carry the experiment a stage farther, in order to ascertain whether the preliminary oil-quench and temper might possibly accelerate graphitisation.

Schwartz had already proved by a special etching treatment that the physical test results were in direct relation to the as-cast structure, and these recent experiments add again to existing knowledge of malleable cast iron and confirm its immense possibilities.

Raw Materials and Their Melting

Metallurgists, or perhaps one should say "chemists," have in the past contended that almost any mixture of pig and scrap which would give a definite required analysis could be relied upon to produce consistent results for a given annealing treatment, and have in consequence derided the old-fashioned foundryman who insisted that pig-iron had inherent properties and that while one brand would give good results, the addition of another brand, even though the same analysis was obtained, would lead to the production of inferior material. The foundryman, for once, was right, and no one has done more to prove this point than Hurst.

These facts are probably the main reason why manufacturers in this country, with few exceptions, have fought shy of the so-called "quick-anneal" method. During the normal, rather lengthy annealing cycle, these inherent differences tend to be ironed out, and do justify the safety factor obtained by such anneals. In fact, one of the biggest producers of short-cycle malleable in the States keeps a metallurgist permanently stationed at the blast furnace from which they draw their iron, stating that the operation of the blast furnace and composition of the burden play an important part in the production of sound castings which will readily anneal.

It has been suggested, and to some extent proved, that superheating of the metal would eradicate these inherent properties. Some investigators claim that nuclei are present to a greater or less degree in different brands of iron when molten. These nuclei are sometimes called graphite nuclei and it is suggested that they affect the precipitation of graphite during annealing. They further claim that superheating tends to refine or dissolve these nuclei. On the other hand, Norbury and Morgan suggest the nuclei are not undissolved graphite, but non-metallic inclusions such as silicates, oxides, sulphides and so on, which have such high melting points that they are solid before the metal

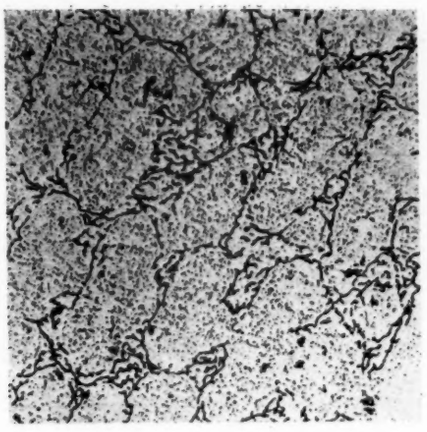


Fig. 22.—Type of Graphite Resulting After Annealing Iron Containing Primary Graphite.

solidifies and thus act as centres for the precipitation of graphite.

Whichever theory be correct, practical experience will confirm that superheating the metal to temperatures higher than those necessary for casting will tend to iron out differences due to the use of different brands of iron, thus rendering control of graphitisation more positive and introducing yet another safety factor.

From a practical point of view superheating must be carried out with caution; it is expensive and this must be balanced against possible advantages, and secondly care must be taken to avoid burning the molten metal. This burning or oxidation is not always characterised by excessive carbon, silicon and manganese losses, and can result in metal of very short life, poor fluidity and so on, which is extremely difficult to correct.

This phenomenon is also sometimes met with in attempting to use large percentages of steel scrap in any furnace other than a cupola. It is suggested that many conservative manufacturers, jealous of their reputations, avoid the use of high steel-scrap percentages. For practical reasons the superheated metal should not be poured from the temperature which it has attained.

In theory various advantages can be tabulated for the use of very high pouring temperatures, such as fine grain size due to chilling, cleaner metal, less risk of primary graphite, but in practice the use of too hot metal means greater fluid contraction—and hence larger feeders. The high contraction, moreover, may lead to the cracking or tearing of castings with thin and thick sections adjoining. So once again theory must be tempered with practice and economy.

In conclusion it seems desirable to stress the fact that malleable iron founders are required to produce castings possessing certain qualities and physical properties, to deliver these at an agreed time, and for a price which is less than that of a similar article made in a competitive material. Moreover, though the fundamentals governing the production of malleable castings have been known for many years, the author hopes that he has succeeded in showing, by demonstrating the application of these fundamentals, that malleable cast iron has immense possibilities and should play no little part in the present war effort. Finally, he wishes to thank the directors of Castings, Limited, Walsall, for their encouragement and permission to give the Paper, and also the B.C.I.R.A., and in particular Mr. Timmins and Mr. Morogh, for their help in connection with the photographs.

Iron and Steel Imports

ADDITIONS TO FREE LIST

The Treasury have issued the Import Duties (Exemption) (No. 1) Order, 1940, which adds to the Free List the following iron and steel goods:—

1.—Railway and tramway construction material of the following descriptions: Sleepers, tie rods, tie bars, fishplates, sole plates and continuous joint plates.

2.—Bolts, whether threaded or not, bolt ends, set screws and screw studs, and other screws for metal, and nuts, whether tapped or not (including washers assembled with any of those articles).

3.—Coach screws.

4.—Rivets (other than bifurcated rivets manufactured from wire and tubular rivets with open ends) and washers.

5.—Wire netting, wire fencing and wire mesh, of all kinds (including woven wire).

6.—Nails (including hobnails and boot and shoe studs and spikes), tacks and staples (other than insulated staples).

7.—Jack chain (including mattress chain) and mattress hooks.

8.—Parts of railway and tramway rolling stock, being products of iron or steel of the following descriptions: Wheels, tyres, axles and buffers.

At the request of the Ministry of Supply the Board of Trade have issued a further Order (the Import of Goods (Prohibition) (No. 11) Order, 1940), adding to the list of goods prohibited from importation, "iron and steel products of the following descriptions: Jack chain (including mattress chain) and mattress hooks." Importers are informed that at present it is not intended to grant licences in respect of the goods covered by this further Order.

Import Prohibitions

Under the Import of Goods (Prohibition) (No. 8) Order, 1940, a number of additions have been made to the classes of goods, the importation of which is prohibited except under licence issued by the Board of Trade. The opportunity has also been taken to make certain amendments of wording in the schedule to the Import of Goods (Prohibition) (Consolidation) Order, 1939.

Goods added to the Import of Goods (Prohibition) (Consolidation) Order, 1939, include the following:—

Blast-furnace slag; iron and steel products of the following description—baths; netting and other mesh of metal, and perforated metal, of a description commonly used in filtering, screening, separating, sifting, sorting and similar operations; latches, hasps, bolts, hinges, locks and keys, parts thereof and blanks therefor; wires and cables, insulated; connectors, couplings, junction boxes, fuses, fuse boxes and parts thereof.

Amendments to items in Import of Goods (Prohibition) (Consolidation) Order, 1939, include the following:—Item "machinery components, etc.," has been amended by the addition of the words "and parts thereof" and "chains and chain," and now reads as follows:—"Machinery components and accessories, the following and parts thereof: Ball, roller and other bearings, balls, bearing blocks and brasses, belts and belting, chains and chain, flywheels, gear wheels, shafts and shafting.

East Midlands Foundrymen's Dinner

Mr. E. J. FOX'S VIEWS ON PROSPECTS FOR HIGH-DUTY IRON

The East Midlands Branch of the Institute of British Foundrymen held its annual dinner at Derby on Saturday, March 9, under the chairmanship of the Branch-President, Mr. R. H. Buckland, A.M.I.Mech.E. On account of war conditions it was not possible to hold the usual dinner-dance and the function reverted to the former practice of gentlemen only, and a gathering of 75 members and guests enjoyed one of the most successful gatherings in the history of the Branch.

At the high table, the Branch-President was supported by His Worship the Mayor of Derby (Alderman A. T. Neal, J.P.), Dr. H. Schofield, M.B.E., Ph.D. (Principal, Loughborough College), Mr. E. J. Fox (managing director, Stanton Ironworks), Sir J. A. Aiton, C.B.E. (managing director, Aiton & Company, Limited), Mr. D. H. Wood (Junior Vice-President, I.B.F.), Mr. C. W. Bigg (Past-President, I.B.F.), Mr. A. Rimmer (Derby Technical College), Mr. S. E. Dawson and Mr. H. J. Beck (Branch Vice-Presidents), Mr. W. T. Evans, Mr. H. Bunting, Mr. T. Goodwin and Mr. A. E. Peace (Past-Branch-Presidents) and Mr. B. Gale (Branch hon. secretary).

Conserving Raw Material Stocks

The toast of "The King" having been duly honoured, MR. E. J. FOX proposed the toast of "The Institute of British Foundrymen." For reasons associated with the present abnormal times, he said, he found difficulty in following lines pursued on previous similar occasions. He was afraid he had to draw attention to points of an unpleasant nature with which the foundry industry was faced. In the first place the industry must envisage the possibility that the supply of foundry pig-iron might become less abundant owing to the necessity of keeping the steel industry supplied with basic iron, which would mean an increasing extent the diversion of blast furnaces from foundry pig-iron to basic iron. In the event of such a diversion taking place, it seemed to him not unreasonable to argue that what foundry irons remained would be required to be used for purposes of national necessity and in a form requiring the minimum of that commodity.

Thanks to the work of the Institute, he said, and to the work of the British Cast Iron Research Association, castings yielding 20 tons per sq. in. as compared with the old standard of 10 to 12 tons had become possible and he fancied the present urge of substituting cast iron for many articles at present made in steel would lend a further incentive towards improving the grade of cast iron, and therefore "out of evil may come good."

The extensive research work and experience which had been freely exchanged within the Institute, whether by means of lectures given or at Technical Committee meetings, had played a large part in the increase in the knowledge of cast iron during recent years.

He desired to draw attention to a recent improvement in practice initiated just prior to the war, and that was the installation of pig casting machines. His company were installing further machines which would take care of all their pig-iron production. Foundries in this country had not become accustomed to using pig-iron in this form, but in America it was common practice. The pigs were small, uniform in size and free from sand. It was true the fracture did not agree with the fracture of iron of similar analysis from a sand bed, but this was immaterial when buying to analysis, as in remelting the resulting metal was normalised according to the silicon content.

As in the past, he concluded, so in the future the industry placed its trust with every degree of confidence in the hands of the metallurgists and technicians, confident that they would keep the foundry flag flying in the forefront of achievement and with these feelings he would give the toast and couple with that the name of the Vice-President, Mr. D. H. Wood.

MR. D. H. WOOD, in responding with a speech interspersed with amusing anecdotes, referred to the work of the Institute and its methods of solving the industry's problems. He thanked Mr. Fox for his continued active interest and encouragement to the Institute and made reference to the E. J. Fox Medal. Commenting upon the war, Mr. Wood said that he recalled the Papers and discussions at the last International Conference for the solving of technical difficulties, and suggested what different conditions would arise if international affairs could be solved on similar lines.

Referring to the East Midlands Branch, Mr. Wood said that his association with the Institute brought to his notice that this Branch had a secretary (Mr. Bunting) who was a member of the Finance Committee for 20 years, and he remembered that Mr. Bunting was apt to report that the expenses of the East Midlands was *nil*, the income £120, and the profit on the year £150, and he hoped that Mr. Bunting had passed on to Mr. Gale the secret of producing such a balance sheet. The Branch, continued Mr. Wood, was a most important one and within his memory had supplied the Institute with two of its most capable Presidents in Mr. S. H. Russell and Mr. C. W. Bigg, and Mr. Russell had now continued his work to take up the position of hon. treasurer of the Institute. The Institute and the Branch should be proud that Mr. C. W. Bigg had been appointed Director of Cast Iron in the Ministry of Supply. He was pleased to say that the work of the Institute was proceeding on almost normal lines. Whilst the outbreak of war had caused a temporary dislocation of activities, the Branches had quickly got into their stride and programmes were being carried through in all centres except one.

A Candid Criticism

Submitting "The East Midlands Branch," DR. H. SCHOFIELD once again proved himself a delightful *raconteur*. Witticisms, stories and criticisms came from him in delightful sequence. Speaking as an educationist, he recalled being introduced at a meeting some time ago, when the chairman proceeded to give a definition of an educationist as "one who casts imitation pearls before real swine." Making no pretence to practical knowledge of foundry work, but as the head of a training college which brought him into constant touch with the industry, he said that he felt, in general, that the industry was not keeping so well abreast educationally as far as its youth was concerned, as were the other branches of the engineering industry. They began well with an excellent Foundry School in Birmingham, but he did not think it had anything like the success the venture merited. It was up to the industry to ask why this was.

In his experience the foundry trade did not get the best recruits, and for this he thought conditions in which their work was conducted must, to some extent, be held to blame. They had to make the foundry environment more attractive and provide schemes for boys, if they were really going to get the best. He did not believe that the dirt was responsible. The automobile engineering industry had plenty of intelligent boys, and in all sense there was sufficient dirt in that job; and he thought the boys revelled in the dirt. At Loughborough they had large numbers of young men who went through the foundry as part of their engineering training, and he had found that the boys liked the foundry and were keenly interested in its problems, but they would not look at it as means of their livelihood and spend all their time in foundries. He agreed that there was some improvement in the foundries about the country, but he was sorry to say that the really good foundries were in a very small minority.

He was always glad to meet the Institute, and he did value the work it was doing. He was very pleased to offer them facilities at the Loughborough College, and he hoped that they would continue to use the college for meetings. He was happy to be present and propose the toast and couple with this the name of Mr. R. H. Buckland.

The toast was enthusiastically received with musical honours.

Local Successes

MR. R. H. BUCKLAND (Branch-President) said his year of office would always remain in memory for two reasons—one that it commenced with the outbreak of war, and the second that they had had to cancel a meeting owing to weather conditions, a feature that had never been known in the history of the Branch. He was delighted at the large attendance of members present that night and expressed his appreciation of the enthusiasm of the members. The attendance at meetings had been very good indeed, and he expressed the opinion that the Institute was one of the most active of technical bodies in this country. He assured Dr. Schofield that the Institute would continue to make the education of its members its foremost object. The East Midlands Branch had a good number of young members in its ranks, and during the past few years in the City and Guilds of London examinations for Patternmaking and Foundry Practice six members passed, and three had received Buchanan Medals. One member had received the City and Guilds Bronze Medal and the Buchanan Bronze and Silver Medals. Credit must in the first place go to the students themselves, and the Branch was proud to have them as members. The Branch was also proud that these young men received their training at the technical college under one of the best known of the Branch members, Mr. Bunting.

The Branch dinner reminded a President that he was drawing to the close of his year of office, and he felt that until one was in that position one did not really appreciate the amount of work necessary to keep the Branch running smoothly, and he expressed his thanks to the Branch Council for their support during the past year, and in particular to Mr. Gale, their secretary. He repeated that one had to be President to realise the work and then he found that all the work was done for him. He thanked Dr. Schofield for the delightful way in which the toast was proposed and the members for the way in which it was received. He concluded by reading a letter of good wishes from Mr. Makemson, who was unable to be present, as he was that night attending a prize distribution at the Scottish Branch.

MR. S. E. DAWSON (Senior Vice-President) proposed the toast of "Our Guests," and expressed regret that illness had caused the absence of some old friends. He made reference to those present and thanked them for their presence.

His Worship the Mayor of Derby and Sir J. A. Aiton responded. The company was then entertained by a concert party.

THE HARDWARE FACTORS' FEDERATION OF GREAT BRITAIN and the Factors' Section of the National Hardware Association are to combine themselves into a new association, which will be known as the Federation of Hardware Factors. Mr. N. Hodgkinson, of the Birmingham Chamber of Commerce, is to act as Secretary.

New Scheme for Distribution of Steel

LICENSING SYSTEM TO BE SUPERSEDED

Distribution of steel supplies under the present licensing system is to be superseded by a new scheme which will be brought into force by administrative Order on April 1. The licensing system, though necessary as a temporary expedient, has not worked perfectly in all respects, it is stated. It has not provided an adequate safeguard against the over-estimating of essential requirements. Even Service departments have been disposed to err considerably in forecasting their needs. Nor has the licensing system been able to assess sufficiently closely the relative urgency of competing requirements. Under the new scheme closer estimating and allocation will meet the needs of all the Service departments and also, it is expected, afford supplies for public services and industrial use on a more adequate basis.

Three main purposes of the rationing scheme are to secure an equitable distribution of available steel supplies; to ensure that the required quantities shall be delivered for Government work and be applied to that work, and to avoid delays in delivery. The scheme provides that a steelmaker shall not accept orders in any quarterly period for a greater tonnage than he has the capacity to deliver in the period, and therefore consumers will be able to base their programmes on fixed delivery periods knowing that for 12 months a definite quantity of steel will be available for the trade in which they are engaged. The quarterly periods will be January 1 to March 31, April 1 to June 30, July 1 to September 30, and October 1 to December 31. In the transitional period before the new scheme is fully operative producers will be instructed not to delay deliveries under the rationing system. It is, of course, essential that supplies should not be interrupted.

Consuming Interests Grouped

To remove the weaknesses of the licensing system it was necessary to obtain a clear ruling on the legitimate claims on available supplies of each Government Department, the public services, and each section of industry. There has therefore been an assessment of the proportionate requirements of each class of consumers in the light of the experience of the last six months and of probable future departmental and trade needs. The figures are not disclosed, but the Departments will in future work to a rationing scale and issue their orders knowing the limit to which they are required to work.

The steel supplies covered by the scheme are listed in the finished forms as ordered by customers from producers and then only in so far as they are not acquired for conversion into any of the other classes of steel so listed. All the consuming interests have been grouped under Government Departments, which, in conjunction with the Iron and Steel Control, will be responsible for the supplies of finished steel to the services covered by the Departments. Thus, the Air Ministry will be responsible for all Royal Air Force requirements, the Admiralty for Navy requirements and mercantile shipbuilding; the War Office for B.E.F. requirements, Army buildings, medical stores, fuel and light, and the Ministry of Supply for all other requirements for the Army and machine tools. The Board of Trade will be responsible for all home civil requirements (except where specifically included under another Department) and for exports of finished steel goods and of steel itself; the Ministry of Transport for railway, road, canal, and port requirements; the Mines Department for the requirements of mines and quarries; the Ministry of Home Security for the requirements for camouflage for screening of blast furnaces; and so on through one Department after another.

Contracts by Government Departments

Each main contractor will be allocated by the Department concerned a total tonnage of finished steel separately for each contract covering all finished steel required for the contract whether by the main contractor or sub-contractors. Along with the allocation there will be given:—(*a*) Department symbol; (*b*) contract number; (*c*) delivery period numbers with total tonnages of finished steel for each period. Sub-contractors ordering finished steel from a producer must also quote these particulars.

All finished steel ordered against each contract will be for direct use in that contract, but the Department may specifically permit finished steel for jigs, tools, dies, packing material, etc., to be ordered against the tonnage allocated to a particular contract. Finished steel for contractors' plant, stores, loose tools and maintenance and repairs, etc., will not, unless specifically permitted, be ordered against the tonnage allocated under a contract.

The main contractor will be responsible to the Department, where required, for the total estimated tonnage of finished steel as supplied by the finished steel producer that will be required for each contract and for the periods of delivery not only for finished steel ordered direct but also for the estimated tonnage of finished steel to cover all sub-contracts.

The main contractor in order to ensure proper delivery of finished steel to his sub-contractor within each delivery period is advised when ordering articles from a sub-contractor to request that sub-contractor to state the estimated tonnage of finished steel as supplied by the finished steel producer that will be required for each delivery period. It is advised that the same procedure be followed by a sub-contractor who is ordering articles from a further sub-contractor.

The main contractor and his sub-contractors will themselves decide what tonnages of the total tonnage allocated will be required in the various classes of finished steel listed to fulfil the Department's contract.

The main contractor will, in ordering either (*a*) finished steel direct from the producer of such finished steel, or (*b*) articles from sub-contractors in which steel will be used, quote:—

(i) Symbol of the Department.

(ii) Contract number of the Department.

(iii) Period numbers for delivery together with the tonnage for each period.

Sub-contractors when ordering finished steel from the finished steel producer must quote (i) Symbol representing the Department; (ii) contract number of the Department for main contract; (iii) period numbers of delivery together with tonnage for each period. Moreover, to ensure within the required periods delivery of finished steel already contracted with a finished steel producer at the date of the commencement of the scheme, each main contractor and sub-contractor is advised to inform the finished steel producer of the Department's symbol, contract number and tonnages with period numbers in respect of each such contract for finished steel on the books of the finished steel producer. In the case of contracts for finished steel placed with a merchant, the main contractor or sub-contractor is advised to give similar information to the merchant with a request that the merchant should in turn inform the finished steel producer.

In the case of a contractor using finished steel from his own stock for the purpose of fulfilling a contract for a Department, the tonnage may be replaced from a finished steel producer or a stockholder by quoting the Department's symbol, contract number and period number. Where finished steel is taken from stock over any one period to fulfil several contracts with different Departments, it will be permissible for a contractor to place one order with the finished steel producer or the stockholder for the whole of the finished steel taken from stock, but all the Departments' contract numbers, with period numbers and tonnage, must be listed along with the order, except that the total estimated tonnage for each Department will only be required.

In the case of a Department or a contractor, for the purpose of fulfilling a Department's contract, ordering finished articles already made and stocked by the manufacturer, the manufacturer, or, in the case of component parts another manufacturer, may replace the tonnage of finished steel used in the manufacture of the finished articles or component parts of same by quoting to the finished steel producer or the stockholder the Department's symbol, contract number and period number, and tonnage of the orders so supplied. If deliveries of finished articles are made in any one period to several Departments, it will be permissible for the manufacturer to place one order with the finished steel producer or the stockholder for the total tonnage used, but all the Departments' contract numbers with period numbers must be listed along with the order, except that the total estimated tonnage for each Department will only be required.

In the case of a contractor ordering finished steel from a stockholder for the purpose of fulfilling a Department's contract, the contractor must quote the Department's symbol, contract number and period number.

Merchants with whom orders for finished steel have been placed for direct delivery from the finished steel producers to their customers will be treated as sub-contractors, and in placing their orders with the finished steel producers must quote the Department symbol, main contract number and period numbers with tonnages.

Government Departments ordering finished steel direct from a finished steel producer, or from a stockholder or from a merchant will quote Department symbol, contract number and period numbers with tonnages for each period.

Export Trade

The Board of Trade will allot a tonnage of finished steel for the manufacture of articles for export, and the Iron and Steel Control will, in consultation with the Board, operate the arrangements in this connection except when the arrangements are made with organised industries. In the case of the motor trade, the Society of Motor Manufacturers and Traders will issue the allocations of tonnage to individual firms both for export trade and for home civil requirements.

The Board of Trade will also allot a tonnage of finished steel for direct export, and the Iron and Steel Control will operate the necessary arrangements. For India finished steel will, until further notice, be dealt with by licence of the Iron and Steel Control, to whom application should be made. For France, exports, whether of finished steel or manufactured articles, will come under the Ministry of Supply.

Stockholders will obtain their finished steel from producers by licence from the Iron and Steel Control. Licences granted by the Iron and Steel Control, other than to stockholding merchants, and not fulfilled by finished steel producers at the date of commencement of the new arrangements will not be withdrawn, but any such licences not fulfilled by June 30 must be referred to the Iron and Steel Control, who will consider their renewal.

List of Finished Steel Products

Following are the finished steel products listed under the new scheme:—

Ingots, billets, blooms and slabs (excluding shell steel) supplied to customers, other than those whose main business is the production of finished steel, *e.g.*, railways, shipbuilders, locomotive engineers.

Plates, medium plates, angles, channels, tees, joists, piling sections, other sectional material, rounds, rods, squares, hexagons, flats, other sections and shapes (and whether black or bright); rails, sleepers, fishplates, soleplates.

Sheets, coated and uncoated, less than 3 mm., including galvanised, leadcoated, R.P.M. and Cellactite sheets.

Tinplates, terne plates, black plates, silver finished plates.

Shell steel.

Steel tubes and pipes (including imported hollows).

Hoops, strip (and whether coated or uncoated, and whether hot or cold rolled).

Tyres, axles, wheels.

Steel castings, forgings, stampings.

Colliery arches and accessories therefor, pit props.

Steel bolts, nuts, screw studs, washers, rivets and screws.

Railway springs (and whether laminated or coiled).

Wire rods, coated or uncoated wire, whether plain or barbed, wire rope, wire strand, wire netting, wire chain link fencing, wire mesh, wire nails, excluding boot and shoe grindery, wire staple, excluding machine staple.

Copies of the scheme may be obtained on application to the Registry, Ministry of Supply, Steel House, Tothill Street, Westminster, S.W.

Melting Operations in the Non-Ferrous Foundry

By FRANK HUDSON

(*Continued from page* 228.)

Gunmetal Melting

With the gunmetals containing copper, tin and zinc, melting operations become of increasing importance, and greater care must be exercised if the best results are to be obtained. All the commercial gunmetals absorb hydrogen, and the degree of absorption depends on several factors. From what has been said in regard to brass it will be apparent that the amount of zinc present will constitute one factor. From the practical point of view it will be agreed that the less zinc present in gunmetal the greater the possibility of trouble. Another factor of even greater importance is the composition of the furnace atmosphere, whether reducing, neutral or oxidising. Melting time, superheat temperature, nature of furnace charge and method of alloying bring up other problems which must be taken into account.

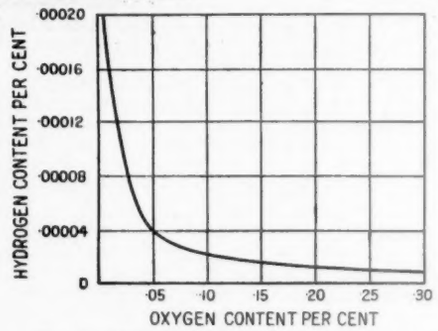


Fig. 1.—Effect of Oxygen Content on Hydrogen Solubility (Allen).

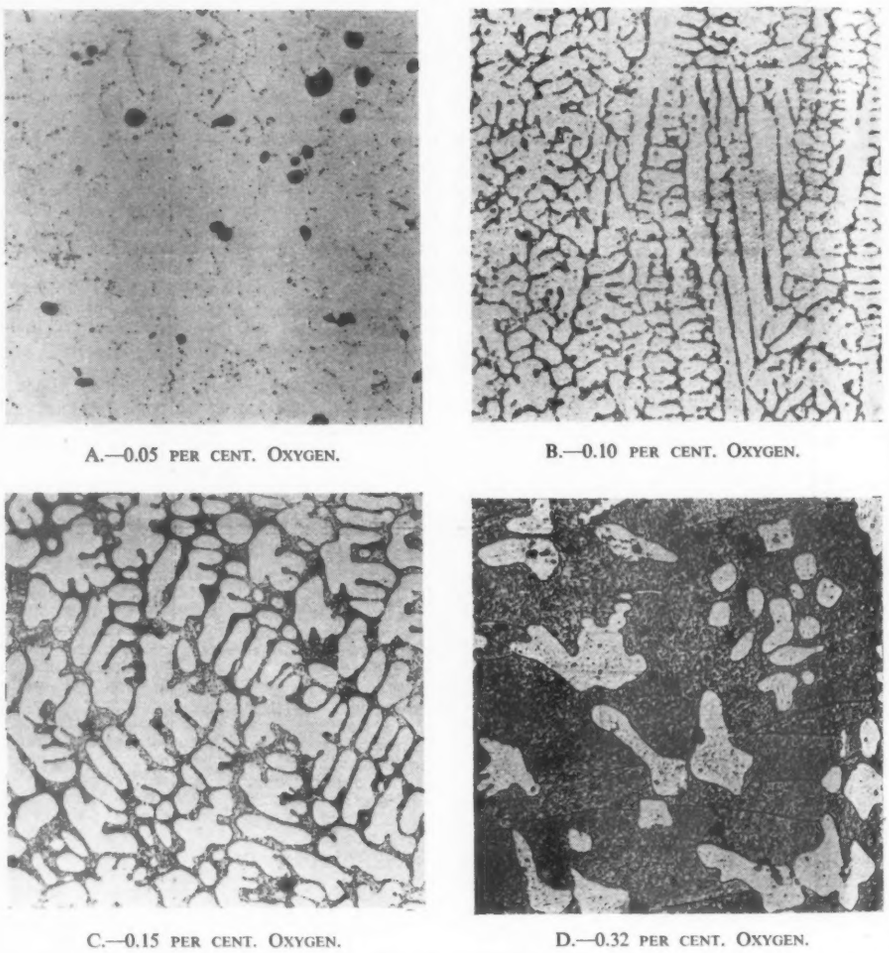
So far as the melting operation is concerned, much can be done to prevent the metal absorbing harmful gases by ensuring an oxidising atmosphere or the presence of active oxides in or on the molten metal. It is useful to note that one has these two alternatives.

In connection with the first alternative, hydrogen is formed during melting as a variable according to the operation and type of furnace employed. In coal and coke fired units the moisture in the air used for combustion reacts with carbon in the fuel at temperatures over 850 deg. C. to form hydrogen and carbon monoxide. (As a matter of interest it might be mentioned that industrial hydrogen is principally made by passing steam over coke at a high temperature.) Reducing conditions assist this reaction, but it tends to be reversible in the presence of carbon dioxide or oxygen, hence the modern tendency for utilising oxidising melting conditions as far as possible.

When using coal for firing, as is common for the production of large quantities of metal in reverberatory or air furnaces, hydrogen can result as a direct decomposition product from the coal. Coal gas, as used for melting purposes, contains around 15 per cent. hydrogen. In the arc furnace, hydrogen is formed through the decomposition of water vapour in the air by the electric discharge. In addition to the above, nearly all the common metals decompose water between a red and white heat with the formation of hydrogen. In view of these examples it is obvious that all industrial melting furnaces are hydrogen producers, if given the opportunity, to a greater or lesser degree. The presence of oxidising gases in furnace atmospheres, either as oxygen or probably as carbon dioxide, limits the amount of free hydrogen produced either from direct reaction or from the dissociation of water vapour. Accordingly, the first effort in the production of good gunmetal castings should consist of ensuring that the melting furnaces in service are capable of giving oxidising atmospheres.

Unfortunately, the present conditions in most non-ferrous foundries in this country preclude this ideal being readily obtained, and some degasification treatment will usually be found necessary. Coke-fired natural-draft furnaces as a class are inferior to oil or forced-draft units in view of the inadequacy or wide variation in the air supply available and the consequent difficulty of obtaining oxidising conditions. With these types of furnaces the addition of oxidising agents becomes more or less essential. Coal-fired, gas and electric arc furnaces, unless handled with skill and special precautions taken, are liable to give gassy metal, and degasification should be thoroughly conducted by one or other of the methods shortly to be described.

Another method of preventing hydrogen absorption mentioned earlier is to ensure the presence of active oxides in or on the molten metal. It has been shown that by ensuring an oxidising atmosphere during melting the presence of furnace hydrogen is minimised. A still more important point is that under such conditions metallic oxides are formed *in* the metal capable of removing hydrogen. For example, hydrogen has a greater affinity for copper oxide than metallic copper and will combine with the oxide to form water vapour, which is evolved from the melt providing an adequate quantity of oxide is present, and metallic copper which is redissolved. Similar reactions take place with nickel oxide.



A.—0.05 per cent. Oxygen. B.—0.10 per cent. Oxygen.

C.—0.15 per cent. Oxygen. D.—0.32 per cent. Oxygen.

Fig. 2.—Microstructure of Chill-Cast Copper Containing Various Oxide Contents. × 100. Electrolytically Polished.

Oxygen in cast copper can be readily detected and the amount present estimated under the microscope at 75 to 100 magnifications. Specimens should be taken at least ½ in. away from a cast or "set" face as the oxide content in surface areas is usually much higher than in other parts. Examination should be conducted after polishing and light etching with a *freshly prepared* 10 per cent. aqueous solution of ammonium persulphate. Small percentages of oxygen begin to show in cast copper as a thin grain boundary of copper-cuprous oxide eutectic, as shown by the above photomicrographs, gradually thickening and filling up the grains until approximately 0.39 per cent. oxygen is reached when the structure consists entirely of eutectic. Above this content spangles of free primary cuprous oxide appear as shown in micrograph 3D.

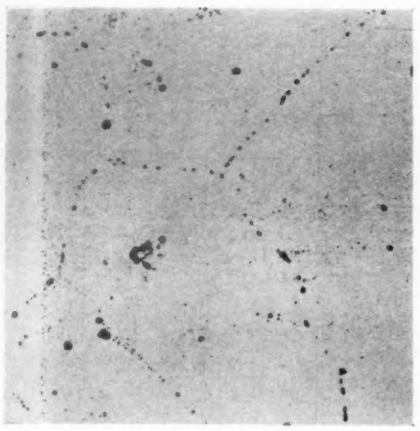
The electric induction furnace of either the low or high frequency type is undoubtedly the best unit available so far as this matter is concerned. Unfortunately, the price of such equipment is beyond the reach of many foundrymen and, furthermore, it does not possess sufficient elasticity for general needs although extremely useful for specialised work. For all general purposes, either oil or forced-draft coke-fired furnaces are hard to beat, providing a plentiful air supply is available. In fact, with proper control, uniform fuel and judicious selection of charge materials, correct melting conditions can be so maintained as to require no additional oxidising technique.

It is thus evident that the presence of copper or nickel oxides in an active form in their respective alloys either as a result of melting conditions, composition of metallic charge or as a definite addition, provides a practical means of overcoming troubles due to dissolved gas. In fact, many founders have already found that degasification conducted by oxide additions is more suited to routine foundry purposes than furnace control.

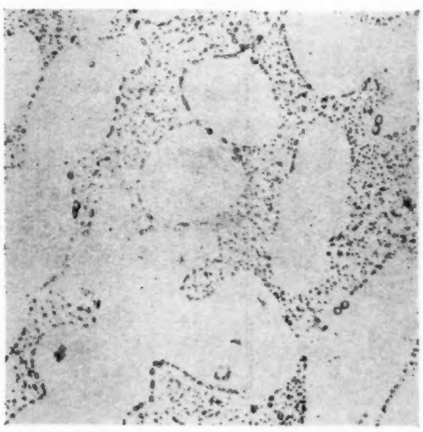
These may be utilised with the initial charge or added after the metal is molten and superheated. Black cupric oxide, added in an amount equivalent to between 1 and 2 per cent. of the charge weight (as well as certain proprietary fluxes) is a satisfactory addition material for incorporating with the charge, whilst red cuprous oxide can be utilised for molten metal degasification. In this latter case around 0.2 to 0.5 per cent. should be sufficient, and this is added and stirred into the metal, preferably in the furnace, a few minutes before pouring.

It is, of course, important that these oxide additions should be perfectly dry. Treatment of the metal after melting has an added advantage inasmuch as crucible attack by the flux is negligible. The use of oxidising slags in the manner suggested is particularly valuable when melting must be conducted under reducing conditions. It must also, of course, be appreciated that gunmetals treated with oxidising media must be properly deoxidised, preferably with phosphorus, before being poured into castings. Phosphorus, as was shown in the case of brass, has the property of reducing nearly all the metallic oxides except that of aluminium,* and such an addition will effectively remove the oxides present in gunmetal if the oxidising treatment has been overdone.

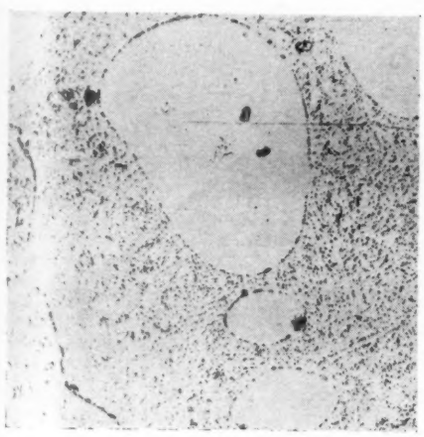
Up to this point in the Paper, it will have been noted that the absorption of deleterious gases by gunmetal can be mainly counteracted by either the use of oxidising melting atmospheres or the direct addition of suitable metallic oxides. There are, however, two subsidiary factors which come into the picture, namely, the initial oxide or gas content of the metals making up the furnace charge and their surface condition and nature. The solubility of hydrogen in copper, for example, has been demonstrated to be dependent on the oxygen content, as shown in Fig. 1. It will be observed that in the presence of 0.05 per cent. oxygen, or above, the hydrogen solubility is at a low level, but rapidly increases with oxygen contents below 0.05 per cent. "Best Selected" copper ingots favoured by the non-ferrous founder contain between 0.05 and 0.10 per cent. oxygen, and there is no doubt that this materially assists casting production by tending to prevent gas absorption and constitutes a probable reason for the popularity of the grade. Fig. 2 illustrates the microstructure of cast copper containing various oxide contents. There are, however, many other grades of copper available with less or even no oxygen at all, and trouble can arise through using such material unless certain precautions are taken.



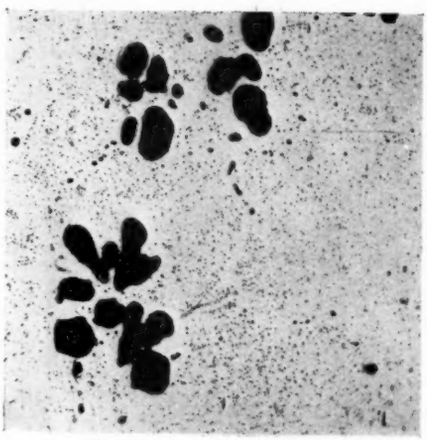
A.—0.05 PER CENT. OXYGEN.



B.—0.15 PER CENT. OXYGEN.



C.—0.32 PER CENT. OXYGEN.



D.—0.50 PER CENT. OXYGEN.

FIG 3.—MICROSTRUCTURE OF CHILL-CAST COPPER CONTAINING VARIOUS OXIDE CONTENTS. × 500. ELECTROLYTICALLY POLISHED.

The author came across a typical example of this recently. A certain foundry producing Admiralty gunmetal castings had made these gasification treatment will usually be found copper ingots melted in natural-draft fires without any special precautions being taken. When they changed over to a brand of oxygen-free copper actually of higher quality than "Best Selected," and they melted this material in their usual manner they were unable to meet test-bar requirements, obtaining about 11.0 tons per sq. in. tensile. These low results were principally due to gas pick-up, probably caused by melting under slightly reducing conditions in conjunction with a lower initial oxide content in the charge. The higher oxide content in the previously used "Best Selected" copper was just sufficient to prevent the absorption of hydrogen.

The trouble was eliminated by adding a small quantity of black copper oxide to the oxygen-free copper during melting, when test-bars giving 20 tons tensile were readily obtained, a value somewhat higher than those previously obtained when using "Best Selected" copper. The detailed melting procedure adopted was as follows:—

(1) Oxygen-free copper ingots melted with 1½ per cent. of black copper oxide and superheated to around 1,250 deg. C.

(2) Molten copper deoxidised with 0.01 per cent. phosphorus.

(3) Zinc added.

(4) Tin added.

(5) Metal deoxidised after skimming and just before pouring with a further 0.01 per cent. phosphorus.

Oxygen-free copper such as "cathodes," an electrolytic form which has not been changed into the tough pitch state by remelting, must be very carefully controlled in the foundry. This type of copper contains appreciable quantities of hydrogen, and in the absence of oxide is liable to give erratic results. Melting under oxidising conditions alone may not provide enough oxygen to meet requirements, but satisfactory results can always be obtained by the addition of cupric or cuprous oxide during melting. In fact, in these days when foundrymen as a whole must work economically, the use of oxide additions to gunmetal is a practice which can be thoroughly recommended to give uniform results regardless of the raw materials employed.

Many foundrymen hold the opinion that remelted metal gives better results than virgin metal for casting production, and in most instances this is no doubt true. A possible explanation may lie in the fact that, with remelting the oxide content tends to be increased, and this reacts as previously described. It should, however, be clearly understood that in the presence of excess oxygen or oxides no difference is likely to be detected between remelted and virgin materials.

So far as scrap is concerned, it will be obvious that material carrying hygroscopic corrosion products may accentuate gas troubles due to the reaction of moisture in the corrosion product with the base metal and the consequent formation of hydrogen. On the other hand, scrap having an oxidised surface, for example copper firebox scrap, or a large surface area in relation to weight which will oxidise readily, such as tubes, borings or light foundry scrap, assists in preventing trouble.

To summarise the position in connection with the melting of alloys in the gunmetal group, the following points should receive consideration:—

(1) Melting atmospheres begin to become of importance, and oxidising conditions should be obtained wherever possible.

(2) The raw material basis of the metal charge has an effect on the results obtained, and quality production is facilitated by the presence of oxides in or on copper or its alloys.

* There is not sufficient evidence as yet to indicate the true effect of phosphorus on tin oxide. Stannic oxide, the tin oxide likely to be formed during melting operations, appears to be reduced by phosphorus to stannous oxide. The latter is soluble in molten soda ash and also probably reduced by phosphorus. On the other hand, reaction between phosphorus and tin oxides may lead to the formation of phosphates. Potassium and sodium reduce tin oxide.

(3) The use of direct oxide addition in conjunction with phosphorus deoxidation affords a convenient way of obtaining uniform melting control.

Bronze Melting

In the production of the copper-tin alloys careful attention to the melting operation becomes of paramount importance, as this group of materials is most susceptible to hydrogen absorption. The author considers that an oxidising treatment by one or other of the methods already described, in conjunction with judicious use of zinc and phosphorus, is essential if the best results are to be obtained, especially so far as sand castings are concerned. Certain precautions are, however, necessary in the presence of appreciable amounts of phosphorus.

The presence of small percentages of zinc appears to lessen the risk of unsound work being produced. It is interesting to note that the well-known 88:10:2 gunmetal was developed, it is thought, because of the difficulty encountered in casting the 90:10 copper-tin alloy originally chosen for high-class steam and water fittings. Even to-day this latter alloy is still specified "zinc-free" by many engineers where maximum resistance to corrosion is required. Phosphor and gear bronzes are further modifications of the 90:10 alloy in which the presence of zinc is looked upon with suspicion. So far as can be seen, there is no evidence whatsoever that small amounts of zinc, say around 0.5 per cent., have any noticeable effect on wearing properties or on resistance to corrosion.

Suggestions have been made in the past that traces of zinc have a deleterious effect on bearing or gear bronzes and on corrosion resistance, but so far as one can see this has never been actually substantiated in service. Personally, it is felt that the presence of under 1 per cent. zinc in bronze is unlikely to deteriorate any of its properties. In fact, it is much more likely that the reverse will apply. Founders should, wherever possible, bring these points to the notice of engineers with the view of getting specifications amended so that at least 0.5 per cent. zinc may be allowed. So far as this Paper is concerned, one of the principal actions of zinc additions to bronze is that this prevents excessive oxidation of tin. In the melting of copper-tin alloys, either from virgin metal or from scrap, under oxidising conditions it may happen that the copper becomes over-oxidised, with the result that tin oxide may be formed in the metal. So long as the copper contains zinc, tin oxide cannot form due to the preferential oxidation of zinc, which thus tends to act as a safety device. The best method of introducing small amounts of zinc is by means of Muntz or brass bar scrap with the initial metal charge.

In addition to zinc, phosphorus will also have to be relied upon for deoxidation purposes. In small quantities, say up to 0.05 per cent., it has little effect upon oxidising melting processes as the reaction, such as was mentioned in connection with brass, between metallic oxides and the small amount of phosphorus present is soon finished with more or less complete loss of phosphorus. Similarly, larger amounts of phosphorus, such as are present in phosphor-bronze, are of little moment, providing they are added *after* the copper has been oxidised. Thus, in the production of phosphor-bronze from all virgin metal an oxidising treatment may be applied to the copper *via* furnace atmosphere or by direct oxide additions with beneficial results. When, however, ingots or scrap containing appreciable amounts of phosphorus form the basis of the charge, direct oxide additions during melting result in a large decrease of phosphorus. When appreciable phosphorus is present during the melting-down perod, probably the best procedure is to try to arrange

(*Continued on page* 248.)

American Foundrymen's Association

PLANS FOR ANNUAL CONVENTION IN CHICAGO

The 44th annual convention of the American Foundrymen's Association will be held in Chicago from May 6 to 10. Concurrently there is to be a Foundry and Allied Industries Exhibition. Both events, according to advance reports, promise to be outstanding successes.

The technical sessions of the convention will start on Monday, May 6, continuing for the week, with both the Convention and Exhibition closing on the afternoon of Friday, May 10. The exhibits will be on display in the International Amphitheatre, one of the best arranged exhibition buildings in America.

A feature of the Convention will be the annual Board of Awards address. This lecture will be given by Mr. Charles E. Wilson, Executive Vice-President of the General Motors Corporation, Detroit, on some phases of industrial business management.

The technical sessions held during exhibition hours will be in the meeting rooms of the Stock Yards Inn and the Saddle and Sirloin Club, buildings conveniently adjacent to the Amphitheatre. Evening sessions will be held at the Palmer House, the central headquarters of the Convention.

Plant Inspections

The AFA Chicago Chapter, host to the Convention, has arranged for many of the interesting industrial plants and foundries to be open for plant inspection during the week. One general group trip has been arranged for the afternoon of Monday, May 6, this being to the works of the Wisconsin Steel Division, International Harvester Company, where the coke and blast furnaces and steel mills will be inspected. Other plants open to inspection during the week are: Carnegie-Illinois Steel Corporation, South Works; Griffin Wheel Company; Interlake Iron Corporation; the Western Electric Company; the Crane Company; the Whiting Corporation; the Link-Belt Company; the National Malleable & Steel Castings Company; Continental Roll & Steel Foundry Company; the Chicago Malleable Iron Company; American Steel Foundries; the McCormick and Tractor Plants of International Harvester Company; Allied Steel Casting Company.

The Chicago Chapter, in addition to the plant inspections, is also planning an Open House and Reception for the late afternoon of Tuesday, May 7, at the Palmer House. An extensive schedule of events for the ladies' entertainment is being worked out, this including a special programme to follow the annual A.F.A. dinner on May 9. This dinner programme will be developed by the Chicago committee along the lines of the chapter's well-known annual Ladies' Night entertainment.

Technical Sessions and Shop Courses

Shop courses on sand control and grey iron practice are scheduled for four sessions each. These will deal with the fundamental problems of everyday foundry practice, the discussion leaders being chosen from leading men of the industry who have devoted attention to these subjects.

Apprentice and foreman training, cost methods, patternmaking, plant equipment, foundry safety and hygiene, time study, sand research and refractories are subjects to be covered by Papers at general foundry interest sessions. In addition, special problems of the malleable, non-ferrous, steel and grey iron foundries will be covered in the forty Papers and committee reports to be presented during the week.

Demonstration of Crystallisation of Metals

An instructional feature of the convention will be the demonstration of crystal formation of metals. Through the use of a microscope projector, Dr. C. W. Mason, Cornell University, will show on a screen material freezing from the molten to the solid state, illustrating the types of metal formations with which the foundryman deals.

Papers to be Presented

Amongst the technical Papers to be presented are:—

"Cupola Operation," by Mr. Donald J. Reese, Mr. John Grennan, and Mr. S. C. Massari.

"Cooling and Storage of Foundry Sands," by Mr. H. L. McKinnon.

"Foundry Equipment at Indianapolis Plant, International Harvester Company," by Mr. F. H. Amos.

"Composite Moulding in a Malleable Foundry," by Mr. Sam Healy.

"An Unusual Structure in Malleable Iron," by Dr. Enrique Touceda.

"Pattern Coating Materials," by Mr. Frank Cech.

"Effects of Manganese on Second-Stage Graphitisation," by Mr. D. P. Forbes.

"Heat-Treatment of Malleable Iron," by Mr. R. J. Cowan.

"Refractories for Cupola Service," by Mr. J. A. Bowers.

"Linings for Desulphurising Ladles," by Mr. John Lowe.

"Flowability of Foundry Sands," by Mr. P. E. Kyle.

"Effect of Sand Conditions on Properties of Castings," by Mr. H. Womochel.

"Application of External Chills to Steel Castings," by Mr. W. F. McKee.

"Application of Controlled Directional Solidification to Large Steel Castings," by Mr. J. A. Duma and Mr. S. W. Brinson.

"Effect of Sulphur on Properties of Electric Furnace Cast Iron," by Mr. F. G. Sefing.

"Desulphurising Cast Iron," by Mr. W. Levi.

"A Safety Programme for Small Foundries," by Mr. P. E. Rentschler.

"Damping Capacity, Electrical and Thermal Conductivities and Endurance Properties of Some Grey Irons," by Mr. E. C. Kron and Mr. C. H. Lorig.

"Tendency of Cast Irons to Seize Under Sliding Friction," by Mr. A. H. Dierker.

"Formation of Various Types of Graphite Patterns in Grey Cast Iron," by Mr. C. D'Amico and Mr. R. Schneidewind.

"The Pearlitic Interval in Grey Iron," by Mr. Alfred Boyles.

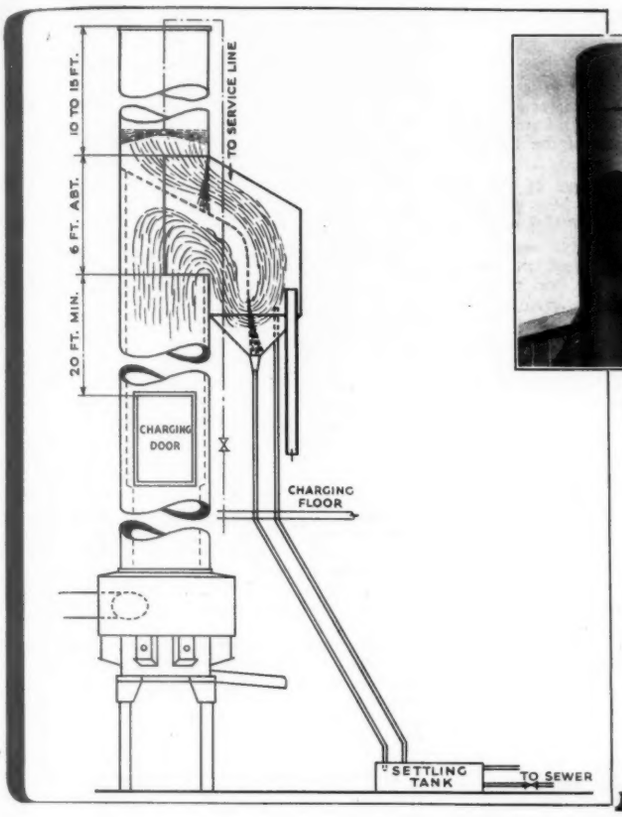
"Steel Castings and Welding," by Mr. J. W. Bolton and Mr. A. J. Smith.

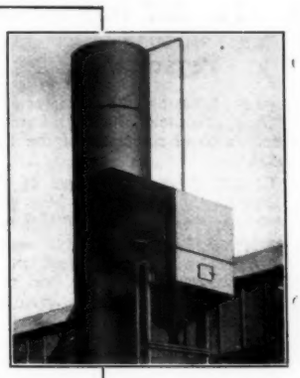
"A Method of Determining Plasticity," by Mr. R. G. McElwee and Mr. R. Schneidewind.

"Cast Iron Cylinder Bores," by Mr. E. K. Smith.

A Research Foundation Foundry

According to "Metals and Alloys," the Research Foundation of Armour Institute of Technology, Chicago, has commenced the building of an experimental foundry which, it is stated, "will have complete research and testing facilities and will provide a large-scale pilot plant." The foundry is to be used primarily in connection with the activities made possible by the Wetherill Research Fund, which was specifically established for the purpose of advancing the method of counter-gravity die-casting of iron and other high-melting-point alloys.





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The Week's News in Brief

Trade Talk

A NEW BLAST FURNACE is in course of construction at Whyalla, South Australia. No information of its planned capacity is as yet available.

RAILINGS AND GATES suitable for the recovery of metal are being taken down in various parts of Rome, to make up for the shortage of scrap.

THE SWEDISH BALL BEARING COMPANY'S net profit for 1939 was kr. 20,141,191, against kr. 20,345,691 for 1938. A dividend of kr. 12 a share (against kr. 10) is recommended.

EMPLOYEES of Duncan Stewart & Company, Limited, London Road Ironworks, Glasgow, have contributed £200 to local infirmaries and charitable institutions during the past twelve months.

THE Minister of Supply has appointed Mr. W. T. V. Harmer to be Controller in respect of chrome ore, magnesite and wolfram. The offices of the Control are at Broadway Court, Broadway, Westminster, S.W.1.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, of Loughborough, inform us that they have opened new offices at 97, Waterloo Street, Glasgow, C.2. Mr. G. B. C. Henderson has been appointed as the company's Scottish representative.

THE ANNUAL MEETING of the Institution of Chemical Engineers, to be held at the Hotel Victoria, Northumberland Avenue, London, W.C.2, on Friday, April 5, will be followed by a luncheon at which the Rt. Hon. Leslie Burgin, Minister of Supply, is to be the principal speaker.

LORD McGOWAN, chairman of Imperial Chemical Industries, Limited, was a guest at a luncheon given by Lord Provost P. J. Dollan, of Glasgow, to mark the first anniversary of the foundation of Scottish Non-Ferrous Tube Industries, Limited, at Hillington. I.C.I. and the Coltness Iron Company, Limited, control the company.

MEMBERS OF the East Anglian Section of the Institute of British Foundrymen are to-day (Thursday) visiting the works of Reavell & Company, Limited, at Ipswich. The annual meeting is being held in the Central Library in the evening, and a sound film entitled "Flow," introduced by Mr. H. H. Shepherd, will be shown.

AT the request of Mr. Leslie Burgin, Minister of Supply, Chambers of Commerce throughout the country, members of the Association of British Chambers of Commerce, are co-operating in the task of bringing the smaller industrial establishments into war production. It has been pointed out that in setting up an Area Organisation throughout Great Britain and Northern Ireland one of the objects which the Minister desires to attain is to bring increasingly into production some of the available engineering capacity of the smaller industrial establishments. It is proposed to examine the offers of capacity of all those firms who wish to be considered for munitions production through the medium of the Area Advisory Committees and the Area Boards which have been or are being set up. The task of bringing the smaller industrial establishments into war production is one in which the Ministry desires to enlist the active help of the industrial organisations of the country. In addition to the Association of British Chambers of Commerce, the Federation of British Industries is co-operating with the Ministry.

Obituary

THE DEATH has occurred in a Glasgow infirmary, following an accident, of Mr. Alexander Jarvie, a member of the Glasgow firm of R. A. King, Jarvie & Company, machinery agents.

THE DEATH took place last week of Mr. George Greenfield, of St. Georges, near Oakengates, Salop, at the age of 86 years. Mr. Greenfield had been employed with the Lilleshall Company, Limited, Shifnal, Shropshire, for 63 years and held the position of foreman of the ironmculding department.

Contract Open

Tattenhall, April 3—The following, for the Tattenhall water scheme, for the Tarvin Rural District Council:—Cast-iron specials; straight pipes; steel pipes and specials; valves and hydrants; cast-iron boxes, covers and indication plates; stopcocks and ferrules; meters; lead pipe; hydraulic test pump; drilling machine. The Engineer and Surveyor, Westminster Buildings, Newgate Street, Chester. (Fee £1 1s., returnable.)

Personal

MR. GEOFFREY SUMMERS, a director of John Summers & Sons, Limited, the well-known steelmakers, has been elected chairman of the Flintshire County Council.

MR. TOM CLEGG, B.Sc., a member of the staff of Torwood Foundry, Larbert, has been presented with a useful wedding gift in the form of a cheque from the staff and directors.

MR. JAMES DEAN, who started work at Burnell & Company's ironworks at Ellesmere Port in March, 1890, at the age of 12, has just completed 50 years' service with the firm.

MR. R. J. BARCLAY, who was a local director of Markham & Company, Limited, brass and iron founders, of Chesterfield, has been appointed director and general manager in succession to the late Mr. Walter C. Macartney. Previously Mr. Barclay had been under-manager in the machine shop of William Beardmore & Company, Limited, Glasgow.

MR. ALEXANDER THORNTON, managing director of Dickson & Mann, Limited, steelfounders, of Armadale, has been presented with a grandfather clock by directors and employees on attaining his jubilee of service. He has been managing director since 1923. Mr. Thornton started in the drawing office of the firm in March, 1890, and became chief draughtsman in 1899. He succeeded the late Mr. David Cunningham as manager in 1912. Two years later he became a director, and when Mr. Mann died he was appointed managing director. The presentation was made in the firm's board room last week.

Wills

SIDEBOTTOM, JOHN, of Stalybridge, for many years associated with John Summers & Sons, Limited, Globe Ironworks, Stalybridge, and Shotton £33,272

SCOTT-SMITH, F. S., of Harrogate, formerly managing director and chairman of Samuel Fox & Company, Limited, steelmakers, of Stocksbridge, Sheffield, and later a director of the United Steel Companies, Limited £85,532

Company Meeting

James Booth & Company (1915), Limited

SIR C. HERBERT SMITH (chairman), presiding at the annual meeting last week of James Booth & Company (1915), Limited, said that the additional capital brought into the business last year had enabled the company materially to increase its productive capacity. Practically the whole of their considerable manufacturing resources were being devoted directly or indirectly to national purposes. The company's accumulated knowledge and experience in the working and production of various non-ferrous metals were proving of great value to the State.

Control of Scrap

LICENCES NOW REQUIRED

The Minister of Supply has made an Order which marks an important change in the method of control of scrap iron and steel. Hitherto it has not been necessary for purchasers to obtain licences to acquire iron and steel scrap save for four special grades, but as from April 1, any person desiring to acquire scrap iron or steel must be authorised by licence so to do, except in the case of a person (other than one operating an iron or steel works or foundry or forge) who confines his acquisitions to quantities not exceeding in the aggregate one ton from any one person in any one week. This exception leaves local authorities and voluntary organisations free to continue house-to-house and other collections of scrap as hitherto. Application forms for licences may be obtained from the offices of the Iron and Steel Control, Steel House, Tothill Street, Westminster. For the time being it is intended to issue general licences to merchants and restricted licences to consumers according to the quality they require.

Reports and Dividends

P. & W. Maclellan, Limited—Dividend of 6 per cent. for 1939.

Wellworthy Piston Rings, Limited—Interim dividend of 5 per cent.

Millom & Askam Hematite Iron Company, Limited—Dividend of 6d. per share.

W. Canning & Company, Limited—Final dividend of 5 per cent. and a bonus of 2s. per share.

Vickers, Limited—Net profit for 1939, after providing for taxation, £1,226,870; brought in, £321,760; to contingencies, £250,000; carried forward, £480,188. Meeting, April 3.

British Aluminium Company, Limited—Net profit for 1939, £647,546; brought in, £144,094; final ordinary dividend of 8½ per cent., making 12½ per cent.; carried forward, £176,640.

Associated Electrical Industries, Limited—Profit for 1939, £1,470,265; brought in, £251,647; depreciation, £234,956; taxation, £758,226; dividend equalisation account, £100,000; ordinary dividend of 10 per cent.; carried forward, £253,118.

John Baker & Bessemer, Limited—Net profit for 1939, £65,824; brought in, £31,061; preference dividend, £10,167; tax, N.D.C. and E.P.T., £25,409; A.R.P., £2,810; to reserve, £20,000; ordinary dividend of 10 per cent.; carried forward, £22,382.

Guest Keen Baldwins Iron & Steel Company, Limited—Profit, after providing for tax, E.P.T. and N.D.C. and expenditure on A.R.P., £682,782; brought in, £74,802; depreciation, £350,000; debenture service, £111,551; notes service, £36,360; dividend on the ordinary shares of 5 per cent.; carried forward, £86,968.

British Insulated Cables, Limited—Profit for 1939, after tax, £783,224; to depreciation, £158,617; debenture interest, £35,000; brought in, £486,558; preference dividends, £57,500; to war contingency reserve, £100,000; reserve account, £13,334; dividend of 15 per cent. and a bonus of 5 per cent.; carried forward, £488,305. Meeting, April 2.

Baldwins, Limited—Net profit for 1939, after providing £120,000 for depreciation, £29,977 for special expenditure at collieries, and £11,954 for staff pensions, and after meeting tax, E.P.T., N.D.C. and A.R.P. expenditure, £278,755; brought in, £43,541; preference dividends, £66,533; ordinary dividend of 10 per cent., £162,158; to contingency reserve, £50,000; carried forward, £43,605.

Swedish Iron Ore for Germany

The Norwegian "Journal of Shipping and Commerce," commenting on the criticisms passed on Norway in connection with the carriage of Swedish iron-ore by ship along the Norwegian coast to Germany, points out that a treaty was concluded, after the beginning of the war, between Great Britain and Sweden permitting the ore trade to continue. M. Koht, Norwegian Foreign Minister, who made this statement in a broadcast last week, said that for practical reasons the export of Swedish ore has been considerably reduced since the war. It was only 640,000 tons in the first six months of the war, against 2,500,000 tons for the preceding six months.

Forthcoming Events

APRIL 4.

Foundry Trades' Equipment and Supplies Association:—Annual general meeting, at the Hotel Victoria, Northumberland Avenue, London, W.C.2, at 2.15 p.m., preceded by luncheon at 1 p.m.

Iron and Steel Institute and Swansea Technical College Metallurgical Society:—"The Influence of the Steel-Base Composition on the Rate of Formation of Hydrogen-Swells in Canned Fruit Tinplate Containers—Part I" by Dr. T. P. Hoar, T. N. Morris and W. B. Adam; and "Practice in the Manufacture of Rimming Steel" (Ninth Heterogeneity Report), presented by J. Mitchell, at the Royal Metal Exchange, Fisher Street, Swansea, at 6 p.m.

APRIL 5.

Institution of Chemical Engineers:—Annual corporate meeting, followed by Presidential Address on "Oil," by F. Heron Rogers, at Hotel Victoria, Northumberland Avenue, London, W.C.2, at 11 a.m. Luncheon in King Edward VII Suite, at 12.45 p.m.

Institute of British Foundrymen

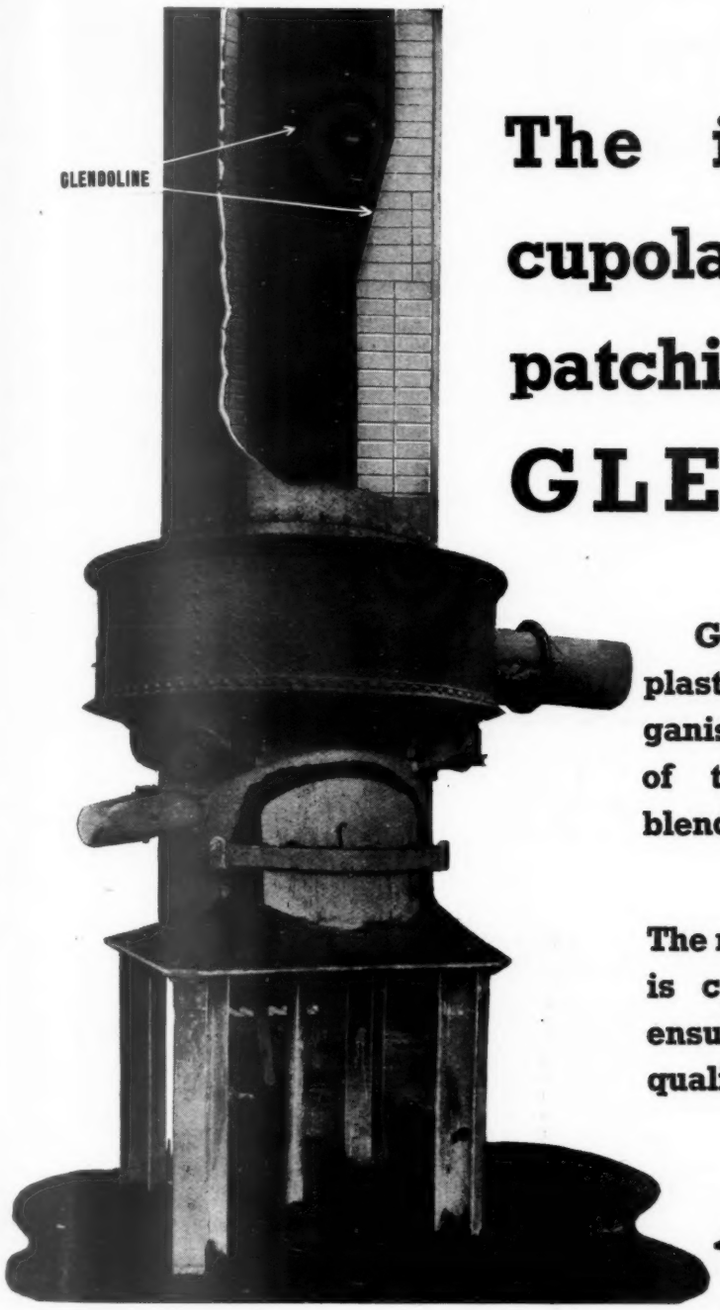
MARCH 29.

Birmingham, Coventry and West Midlands Branch:—"Manufacture of Electric-Motor Castings," Paper by J. Hird, at James Watt Memorial Institute, Great Charles Street, Birmingham, at 7 p.m.

Falkirk Section:—Annual general meeting, at Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

APRIL 6.

Lancashire Branch:—"Patternmaking and Foundry Production." Paper by C. Joynes, at Engineers' Club, Albert Square, Manchester, at 3 p.m.



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Raw Material Markets

The Easter holiday has passed with much less interruption in the iron and steel industry than usual. Where possible, both producers and consumers were idle for a few days, in order to carry out repair work and to give the men the opportunity of taking a well-earned vacation. The blast furnaces, of course, maintained full outputs over the holiday, which gave them a chance to make up some leeway in their commitments. Heavy foundries resumed with order-books filled to capacity, but the position of the light foundries still gives cause for dissatisfaction. With the building trade operating at a very reduced level, the outlook for light castings is not promising, and makers are hoping to procure Government work to alleviate their position.

Pig-Iron

MIDDLESBROUGH—Some respite was accorded to the ironworks over the Easter recess, but this is only a temporary feature of the trade, and the demand for deliveries is now again insistent. Most of the blast furnaces in the Cleveland area are engaged on the manufacture of iron to meet the substantial requirements of the steel industry and the production of foundry iron continues to be suspended. Consumers of the latter are able to procure good supplies from other districts for the time being, but there is little likelihood of any early resumption of Cleveland foundry iron production. The heavy foundries have as much work as they can accept on Government account, supplemented by a considerable number of shipbuilding specifications.

Heavy demands continue to be made on makers of East Coast hematite, and there is little material to spare after current commitments have been met. Apart from local needs, there is also a substantial demand from other districts which has to be met on the East Coast. The recent holiday afforded some relief to makers, as users generally were idle for a few days. Business is perforce of a hand-to-mouth character, and export transactions cannot be considered in the circumstances.

LANCASHIRE—Consumption of pig-iron is well maintained, and, although users were less insistent over the holiday, the future promises active conditions. Speciality concerns particularly are taking up heavy tonnages, Government contracts being placed with these works on a good scale, but there is no improvement to report regarding the light-castings trade. Certain jobbing foundries, too, are badly situated for orders and only intermittent operations are possible in many instances. Makers of textile machinery are slightly better placed on the whole, but this section is not yet working really satisfactorily. Deliveries of West Coast hematite are good and steady business seems to be going through.

MIDLANDS—The quietude of the building trade has not as yet been offset by Government orders as far as makers of light castings are concerned, and their lot is still far from being a happy one. The wartime situation of building has seriously affected this branch, and prospects are not bright, although it is expected that Government departments will make increasing use of light foundries as the war progresses. Heavy engineers, on the other hand, are very active and are not always finding it easy to obtain their full iron requirements. These works use low-phosphorus iron and hematite, which are fully taken up, whereas the light engineering works use high-phosphorus iron, which can generally be procured in good tonnages. As a result of the stringency in supplies, particularly in low-phosphorus iron, users are having to make use of grades which they would not accept in normal circumstances. However, the inconveniences caused by these changes are being surmounted in most instances.

SCOTLAND—With shipbuilding very active in this area, the heavy engineering concerns are being kept fully employed dealing with specifications from this source and the future is likely to hold a continuance of these conditions. Light-castings makers, on the other hand, are poorly situated, being hampered by the absence of building orders, which have dried up owing to the war. Consequently, only part-time work is generally possible at most works. Others are more fortunate and can still find sufficient employment to keep their factories operating at full time. Hematite is well taken up, while outputs of basic iron, supplemented by large imports, are finding a ready market.

Coke

The strength of the foundry-coke market is maintained; in fact, the demand appears to be expanding, many users being anxious to cover their forward requirements again, as stocks were depleted early in the year when transport problems were acute. Thus, ovens are busy, but they are mostly well placed and able to meet their commitments. For delivery to Birmingham and Black Country stations, the current price of Durham best foundry coke is 53s. per ton minimum. Any change in this price is likely to be in an upward direction, but the Control have not yet given any intimation of their intentions in this respect.

Steel

Details of a new scheme whereby distribution of steel under the existing licensing system is to be superseded by a plan evolved to make the allocation of supply more equitable are to be found elsewhere in this issue. It is expected that the new scheme will ensure additional attention to Government contracts, which should thus be fulfilled more expeditiously. Other provisions of the scheme have been made with regard to makers' outputs, making it simpler for consumers to estimate the amount of steel likely to be available for their particular trade over a set period. Only a short holiday was taken by the steelworks at Easter and a resumption of full-scale operations has been made. Works are fully booked up over a long time ahead and almost all departments are universally busy.

Scrap

Under the Control of Iron and Steel (No. 7) (Scrap) Order, 1940, Direction (No. 2) which has been issued by the Ministry of Supply to supersede the Direction (No. 1) issued with the Control of Iron and Steel (No. 7) (Scrap) Order, 1940, supplies of iron and steel scrap after March 30 will only be obtainable subject to licence. Hitherto it has not been necessary for purchasers to obtain licences to acquire scrap save for four special grades. The Order applies to all consumers except in the case of a person (other than one operating an iron or steel works or foundry or forge) who confines his acquisitions to quantities not exceeding in the aggregate one ton from any one person in any one week.

Metals

While the Easter holiday had a quietening effect on the demand for non-ferrous metals from ordinary commercial users, the call for deliveries from the many works engaged on Government contracts was unabated. Priority users of copper continue to take up large tonnages. The copper situation in the United States is reported to be still on the quiet side. The tone of the tin market has been rather dull, with the trend of prices still downwards.

Metal Exchange prices for tin this week have been as follow:—

Cash—Wednesday, £248 15s. to £249; Thursday, £250 5s. to £250 10s.; Tuesday, £247 5s. to £247 10s.; Wednesday, £245 10s. to £246.

Three Months—Wednesday, £247 5s. to £247 10s.; Thursday, £248 10s. to £248 15s.; Tuesday, £245 10s. to £246; Wednesday, £243 15s. to £244.

There seems to be rather more spelter available, for distribution primarily among concerns holding Government orders. Consumption is unquestionably at a high level and many users engaged on ordinary civil work would appreciate freer deliveries. The position of lead is much the same.

Increased supplies of copper and aluminium scrap seem to be available, holders of the latter now appearing to realise that it is unlikely that prices will appreciate further in the future. A fair amount of business in scrap was done prior to the Easter holiday for delivery after the vacation.

Merchandising Castings

(*Continued from page* 233.)

a business-like machine-tool finish of iron grey, to match the efficient-looking tractor with which they are now all so familiar. For the market which is dominated by the peon, the negro and those innumerable races to which bright colours appeal, their particular likes and dislikes must be catered for. For instance a brilliant orange might not help to sell a machine in certain parts of Ireland, whilst good luck and bad luck are associated with colours in the less industrialised parts of the world, just as the number 13 does not meet with general approbation in the luxury hotels of large cities!

For engineering castings, it is possible that the following postscripts could be usefully added to Mr. Templeton's precepts:—(1) With each delivery, printed matter should be attached, giving (*a*) the physical and especially the machining properties of the castings, and (*b*) the name of the service man in case of complaints. (2) All castings should be "trade-marked" to avoid being saddled with some other foundry's productions. (3) Publicity matter should accompany the goods, giving details of other types of castings made. By this system, useful contact is made with the man actually handling the firm's catalogue. The mistake must not be made, however, of giving any material to, say, the machine-shop foreman or stores superintendent which is not already in the hands of the buyer. The seller must assume that these various officials are on the best of terms, and that relationship must be fostered by the suppliers.

Melting Operations

(*Continued from page* 244.)

for rapid melting with oxidising furnace atmospheres so that the presence of deleterious gases available for absorption by the metal will be as little as possible.

In the melting of the bronzes it would thus appear necessary to modify the technique required according to the type of bronze being made along the following lines:—

(1) Melting atmosphere is of special importance for all the true copper-tin alloys, and this must be oxidising.

(2) A small addition of zinc improves production and casting quality.

(3) Deoxidation with phosphorus should always be practised after oxidising and before and after the addition of tin.

(4) Direct oxide additions can be utilised to counteract the effect of hydrogen pick-up providing the basic furnace charge is free or low in phosphorus.

(5) Should the basic charge be high in phosphorus, gas absorption should be minimised by the use of oxidising furnace atmospheres in preference to a heavy direct oxide addition unless followed by an adjustment to make up for loss in phosphorus content. The use of relatively small additions (0.2 per cent.) of red cuprous oxide after the metal has melted assists degasification with less phosphorus loss.

In the melting of special alloys for sand castings such as nickel silver, which, unlike brass, is highly susceptible to gas reactions, cupro-nickel and Monel, etc., it can be truly claimed that the use of oxidising melting treatments followed by adequate deoxidation have been primary factors in establishing satisfactory foundry technique.

In conclusion, it might be noted that the remarks made in this Paper are principally directed in connection with the production of sand castings. It will be appreciated that the amount of gas evolved bears a relation to the rate of solidification, less being given off the more rapidly the casting is cooled. Accordingly, in the production of chill or centrifugal castings careful control of melting operations is not so important.